Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

JUNE, 1955

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TECHNOLOGY DEPT.
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JUL 1 1955

HIGH-SPEED TANDEM COLD MILLS

sta 56" Four-High, Four-Stand Tandem Cold Mill
alled at the Brackenridge Plant of Allegheny-Ludlum Steel Corp.

Designed and Built by MESTA

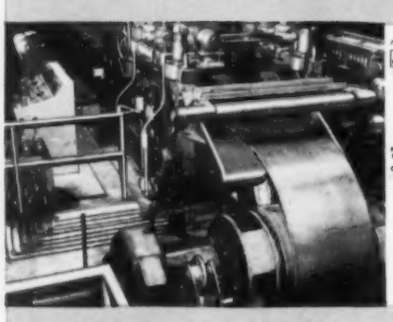
FOR THE COLD REDUCTION OF STAINLESS, SILICON, HIGH-ALLOY AND CARBON STEELS

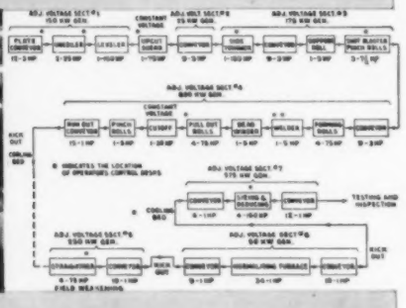
Designers and Builders of Complete Steel Plants
MESTA MACHINE COMPANY
PITTSBURGH, PENNSYLVANIA

the Lone Star Steel *Achievement*★

and the Name on the Motor Control

Over 200 feet of 90" high panels mount C-H Motor Control for Lone Star No. 1 Mill shown above.





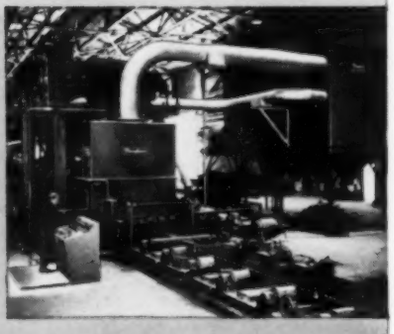
(At left above) Coiled skelp feeds from uncoiler into flattener.

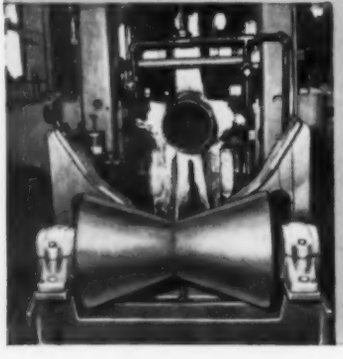
(At right above) Diagram shows sectionalization of Adj. Voltage Drives. AUTOMATION (closed loop control) is found in first 4 sections.

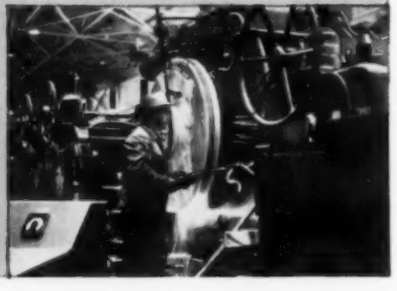
(At right) Blasting machine readies edges of plate for welding.

(At left below) Formed plate emerges from forming mill ready for welding.

(At right below) Largest resistance welder of its type. Wheel electrodes use ignitron contactors.







A gigantic machine is the Yoder Company's No. 1 Pipe Mill at Lone Star Steel. A machine continuously, automatically taking in skelp at one end and pushing it out at the other as completely finished pipe. Never before has pipe of this type from material of this character been continuously electric-weld produced. Never before, the experts agree, has it been possible. Yet fundamentally the individual machines that make up the integrated process are not new. What then is the secret? To a large extent it is found in the motor control that guides and integrates the hundreds of motors, the generators, exciters, alternators and machines on this line. And the secret of the motor control is the name found on that control . . . Cutler-Hammer, pioneer since 1892, constantly blazing new trails that enable machines, processes and mills to reach new highs in performance. Here is a store of experience such as you are likely to find nowhere else and always available to you—whether you plan a new mill installation or simply want to solve a present burdensome application problem.

Look to Cutler-Hammer for the simple, sure solution that means new efficiency, new dependability, new productiveness . . . an installation that goes right to work. Cutler-Hammer experience is as broad as it is long. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

★ FIRST electric weld mill making J-55 casing from slit skelp . . . to use flying cutoff on 16" pipe . . . completely conveyorized, automatic from skelp to finished pipe.

CUTLER-HAMMER
MOTOR CONTROL
C-H

LOOK TO CUTLER-HAMMER MILL EXPERIENCE...AS BROAD AS IT IS LONG

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., Pittsburgh, Pa. Second class mail privileges authorized at Pittsburgh, Pennsylvania, January 25, 1924.

can YOUR production equipment KEEP UP WITH THIS MARKET?

★ By 1965, the experts predict there will be 80 million automobiles in existence, as compared to some 50 million now.

For that traffic load, more than 50 billion dollars will be needed to rebuild the 3,350,000 miles of existing roads and to build new super highways.

Each million dollars of highways requires between 420 and 450 tons of steel. Each automobile averages about 3,500 pounds of steel, plus many pounds of copper, brass, aluminum, rubber and plastic.

Will you lose out competitively on this big market on poor quality of product or slow production equipment? Good equipment brings down production costs and improves product quality.

Aetna-Standard designs and builds equipment for producing, processing and fabricating steel, copper, brass, aluminum, rubber and plastic. Here is one example—an 80" Sheet Side Trimming and Shearing Line at the Fairless Works, U. S. Steel Corporation. Other Aetna major product lines include: Pipe Mills (Seamless and Butt Weld); Continuous Coating Lines; Rolls; Drawbenches; Machinery for Rubber and Plastic.

SUBSIDIARY and ASSOCIATED COMPANIES

The Aetna-Standard Engineering of Canada, Ltd., Toronto, Ontario, Canada.
The Head Wrightson Machine Company, Ltd., Middlesbrough, Eng.
Societe de Constructions de Montbard, Montbard, France.
Demag Aktiengesellschaft, Duisburg, Germany.
Compagnia Italiana Forme Acciaio, Milano, Italy.
Aetna-Japan Company, Ltd., Tokyo, Japan.
Engineering and Development Corporation of the Philippines, Manila, P. I.
Hale and Kullgren, Inc., Akron, Ohio.
M. Castellvi, Inc., New York, N. Y.
Standard Engineering Co., Ellwood City, Pa.
Trans-World Traders, Inc., Pittsburgh, Pa.

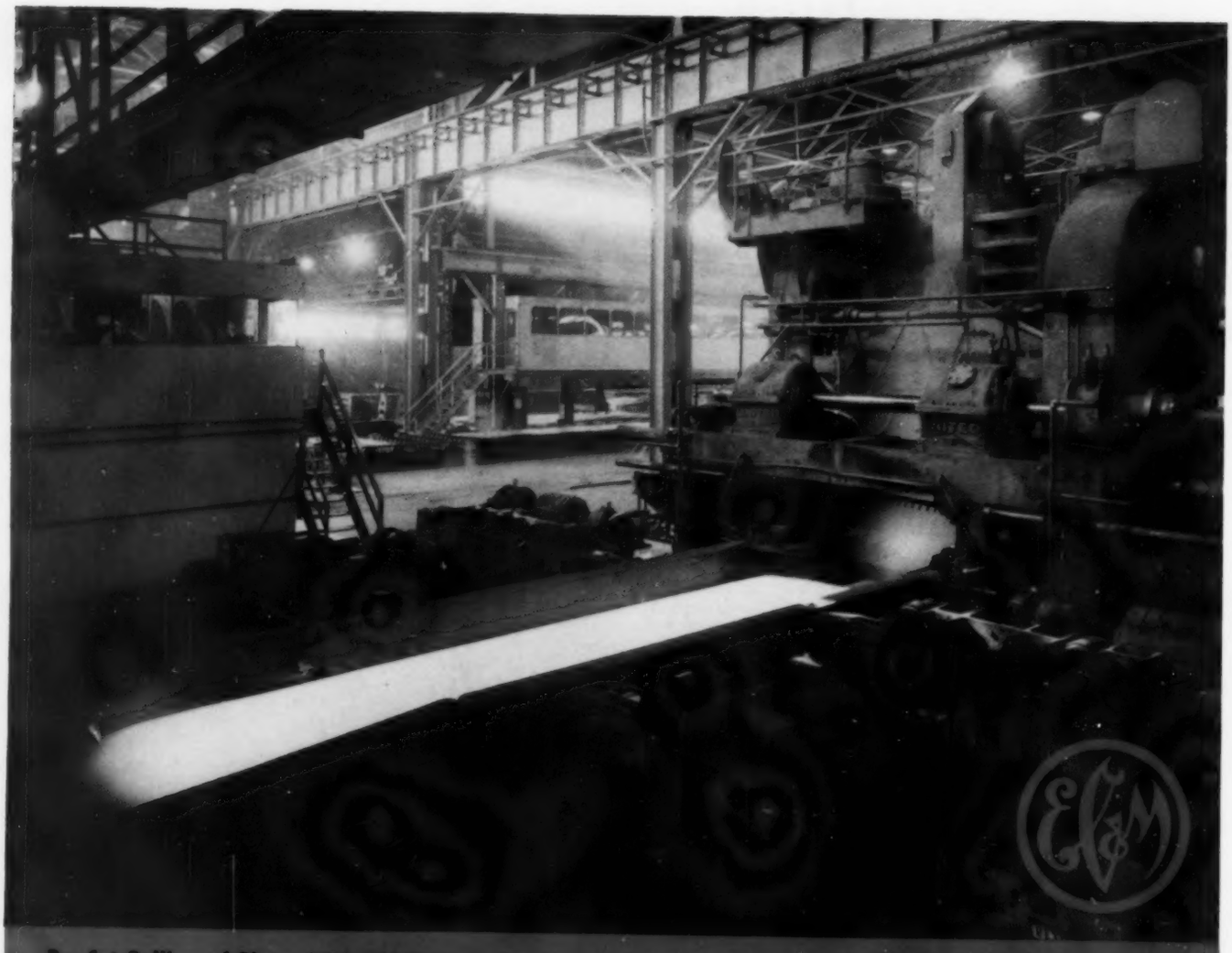
Designers and Builders to the Steel, Copper, Brass, Aluminum, Rubber, Plastic and Chemical Industries

THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Aetna-Standard

PLANTS IN WARREN, OHIO • ELLWOOD CITY, PENNSYLVANIA

GOOD EQUIPMENT BRINGS DOWN PRODUCTION COSTS



Pre-Set Rolling of Plates With EC&M Automatic Screwdown Control. Screwdowns, edgers, and sideguards move to exact rolling dimensions automatically under single push-button operation. Operator is stationed in enclosed, elevated pulpit with clear view of all operations in this large, 120-inch plate mill. This simple EC&M control is used in several mills throughout the United States, resulting in improved product, faster rolling with extreme accuracy.

Like An Organ Player, The Operator Rolls Steel from button-panel using schedule No. 1 while an assistant prepares schedule No. 2 for a change in rolling requirements.

Also In This Same Plant Is The World's Largest Plate Mill (shown above). It has been EC&M controlled for many years.

WRITE FOR BOOKLET 9250

THE ELECTRIC CONTROLLER & MANUFACTURING COMPANY, 4498 Lee Road, Cleveland 28, Ohio

Tube Testing Machine

by SCHLOEMANN

Ferrous or non-ferrous, seamless and welded pipe of standard sizes can be hydraulically tested with maximum efficiency on Schloemann tube testers. Double action testers (as illustrated) can be arranged for full-automatic or push button operation.

You are invited to contact Feller engineers for complete information.

Existing Equipment by SCHLOEMANN

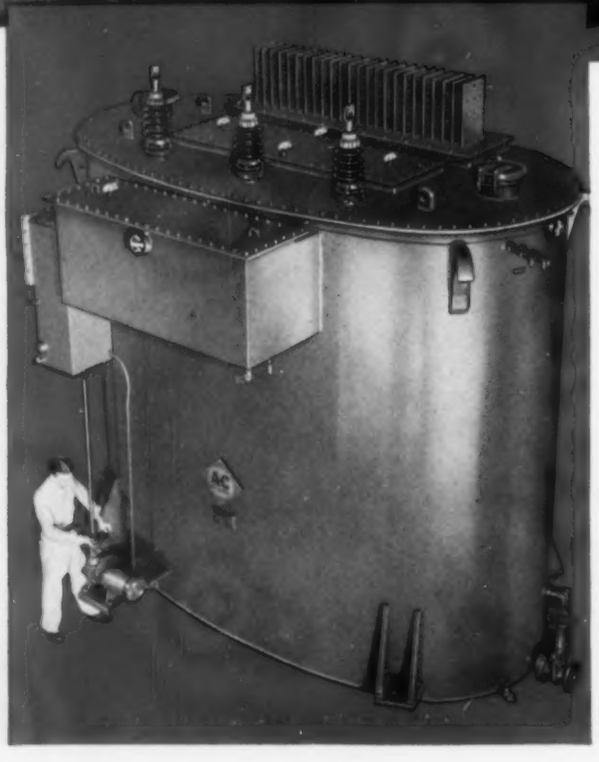
Domestic users of equipment built by Schloemann are assured of competent service-engineering, supply of genuine spare, and repair parts. Call a Feller service engineer.

FELLER ENGINEERING COMPANY

[illegible] Empire Building, Pittsburgh 22, Pa.

Exclusive U.S. Agent

Reduce Cost of



TRANSFORMERS

Well-balanced design and extra-heavy duty construction are used in the Allis-Chalmers arc-furnace transformer. Past records show ability to withstand as much as 25 to 30 years of the repeated daily short circuits encountered in furnace operation. Extremely heavy supports and structure are used to brace coils against the severe short-circuit stresses.

Skillful insulation techniques protect windings from overvoltage due to wide tap range. Some units are designed for as much as 50% range in secondary voltages. Tap-changing mechanism, specially designed for arc-furnace transformers, is in separate compartment to facilitate maintenance. Wide flat contacts provide the long life needed for numerous daily tap-changing operations.

ALLIS-

Arc-Furnace Steel

Use Allis-Chalmers Integrated Electrical Equipment—and you...

SAVE **on Engineering** — Allis-Chalmers steel mill specialists coordinate equipment, submit single complete package proposal.

SAVE **on Purchasing** — One order, one invoice, one follow-up for the complete furnace electrical system.

SAVE **on Installation** — All components are matched for easy installation. Delivery is coordinated to prevent delays.

SAVE **in Operation** — All equipment is designed and built to work together. One reliable supplier guarantees performance of complete electrical system.

TAKE ADVANTAGE of Allis-Chalmers complete line of arc-furnace equipment—transformers, *Regulex* control, switchgear, associated controls—backed by 45 years of experience. Call your nearby Allis-Chalmers District Office for assistance when you are planning new facilities or modernization. Or write Allis-Chalmers, Milwaukee 1, Wisconsin.

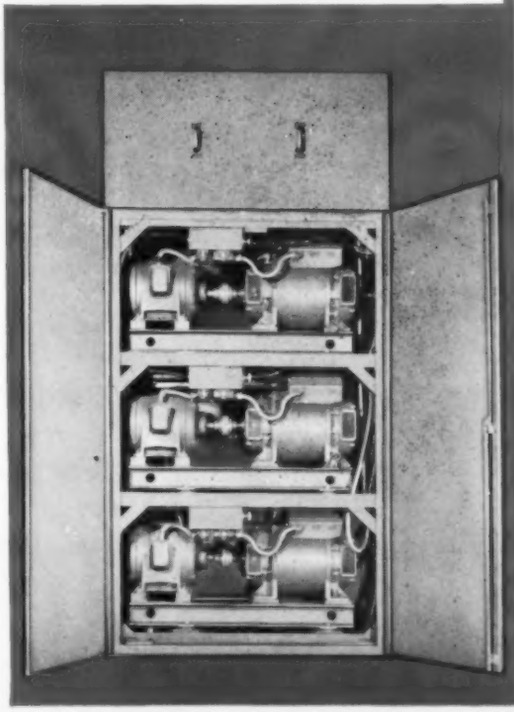
Regulex and *Ruptair* are Allis-Chalmers trademarks. A-4742

REGULEX CONTROL

Balances arc current with arc voltage almost instantly—maintains desired arc conditions by automatically varying distance between electrode and charge.

With *Regulex* rotating amplifier there are no contacts or switching devices between the regulator and electrode motor. Continuously closed circuit provides constant positive control, minimizing current surges, cutting power consumption.

Simple design of *Regulex* results in lower maintenance. Provisions for spare unit mounted on top assure continuous operation under all conditions. Tier construction — open or enclosed —conserves valuable floor space.

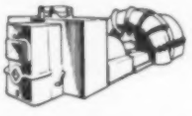


Other Allis-Chalmers Equipment for the Steel Industry

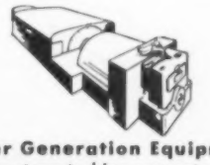
Wide Range of Motors for main mill and auxiliary equipment drives—ac or dc—from 1 hp to 10,000 hp—and supporting m-g sets or rectifiers.

Transformers for mill service include metering transformers, distribution transformers, power transformers, and unit substations.

Switchgear ranges from low voltage metal-enclosed units to large metal-clad types — includes *Ruptair* and oil circuit breakers. Also large power circuit breakers.



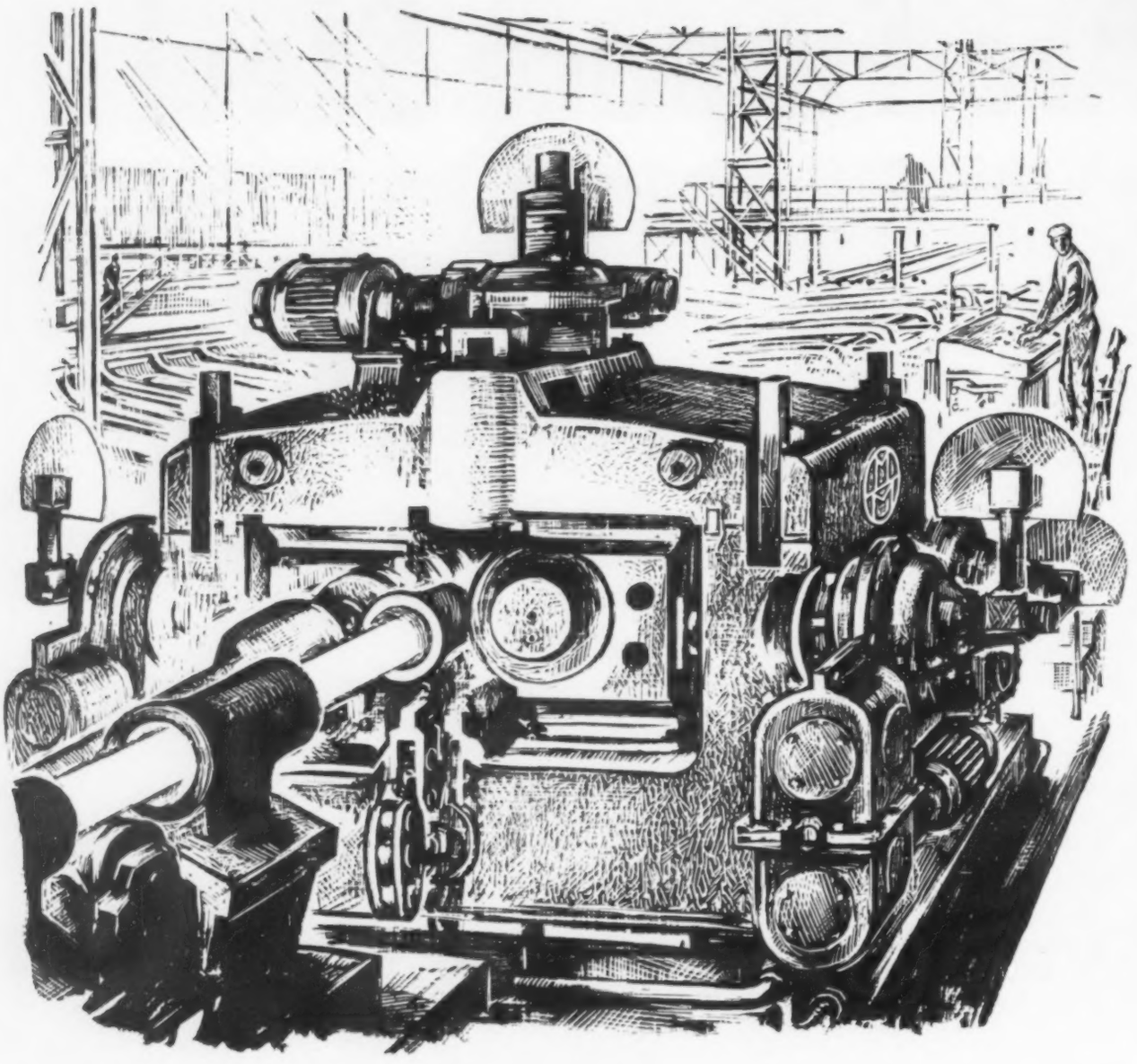
Blast Furnace Blowers are a part of the A-C line of single and multi-stage blowers, axial and rotary compressors, and vacuum pumps for the steel industry.



Power Generation Equipment includes steam turbine-generator units 2000 kw and larger for fluctuating steel mill loads. Also condensers, pumps and auxiliary-drive motors.

CHALMERS

A-C ALLIS CHALMERS



Do You Think Your Reelers Are Heavy Enough?

Most seamless mill operators do not think so! Attempts to speed up production of automatic seamless mills usually are stopped at the reelers because they are not heavy enough to take on more work at higher speeds.– Mannesmann-Meer's modern automatic seamless mills are equipped with heavy reelers of the most advanced design. Working rolls have angular adjustment in both planes to allow for variation of the feed angle which will provide ideal rolling of a wide range of sizes and grades of steel. With Mannesmann-Meer reelers it is possible to roll with an expanding pass and still to get good smoothing action.–

Mill design is considerably simplified by driving each roll with a separate motor. A rugged inlet table design features closed barrel guides to end danger and trouble from split guides. Roller type mandrel bar steadiers make possible smoother reeling operation.– In addition to all of these features Mannesmann-Meer reelers are especially designed for quick schedule changeovers.

Why don't you call us in to see what Mannesmann-Meer's outstanding combination of

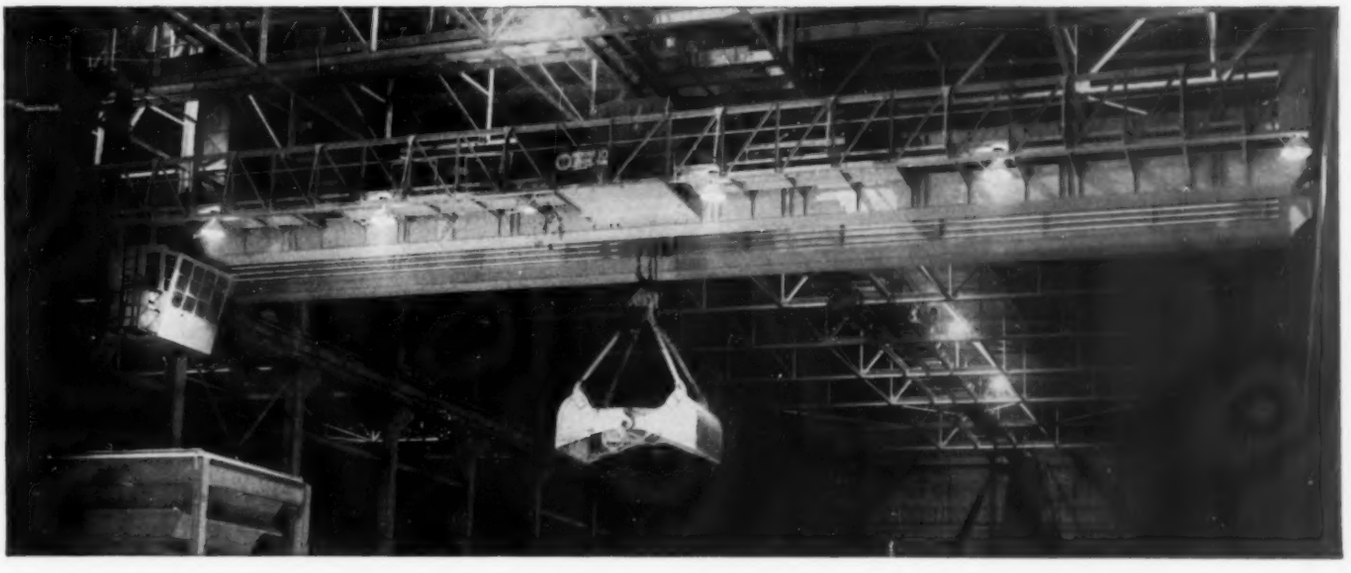
- CREATIVE ENGINEERING
- DESIGN EXPERIENCE
- OPERATING BACKGROUND
- AMERICAN MANUFACTURING SKILL

can offer you to modernize your seamless mill.

MANNESMANN-MEER

ENGINEERING AND CONSTRUCTION COMPANY, 900 LINE STREET, EASTON, PENNA

WORLD SPECIALISTS IN HIGH-SPEED TUBE MILL MACHINERY



For advanced design . . . higher production Specify Bedford Bucket Cranes

In the steel industry, as throughout all industry, more and more important producers are specifying Bedford Cranes.

The big swing to Bedford Cranes is further evidenced by the high percentage of repeat orders from experienced crane users who require and *expect* superior performance.

Backed by more than half a century of *specialized* crane engineering and fabricating experience . . . Bedford Cranes have won fame the world over for advanced design and for safe, smooth, dependable performance.

Available in all types and sizes . . . from 5 tons to 350 tons . . . for all kinds of indoor and outdoor service . . . each Bedford Crane is individually engineered for its specific application.

• • •

Consult a Bedford engineer on your next crane problem . . . with all the facts on the table we believe you too will make your next crane a Bedford.

(Write for complete catalog describing Bedford Cranes in detail)

ENGINEERED CRANES BEDFORD

BEDFORD CRANE SERVICE

New York Office: 30 Church St., Room 426
New York 7, N. Y., Phone COrtlandt 7-1896

Pittsburgh Office: Oliver Building, Room 1141
Phone ATlantic 1-0136

BEDFORD FOUNDRY & MACHINE COMPANY, INC. • BEDFORD, INDIANA

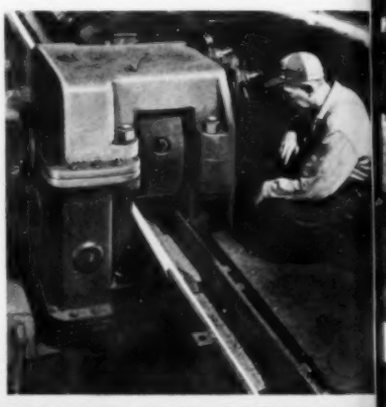
ROLL BARS AT LESS COST on a Continental mill like this

Complete mechanical handling speeds up production

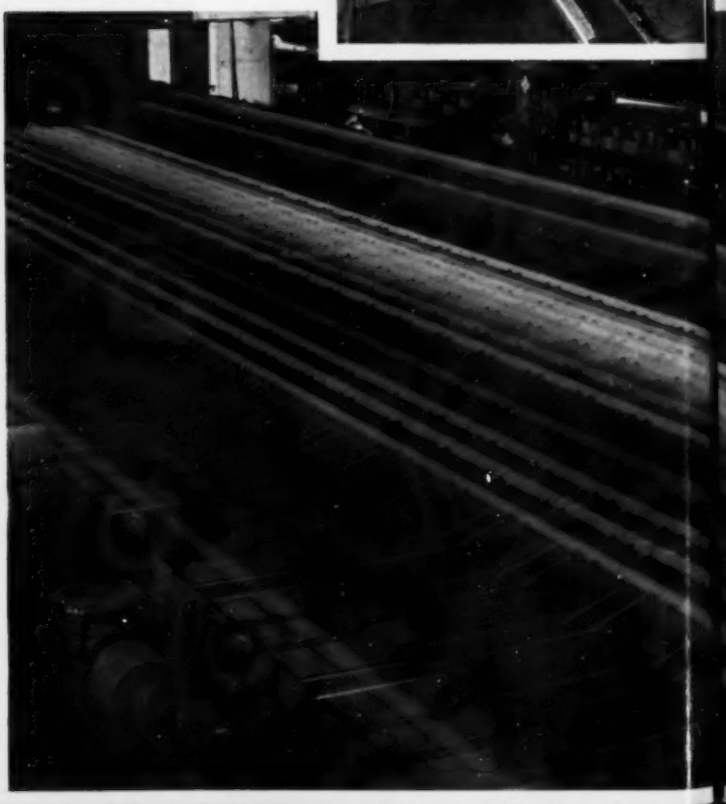
You don't see any tongsmen on this CONTINENTAL merchant bar mill. They are not needed. CONTINENTAL skew tables, repeaters, snip shears, drag-over transfers, test bar and parting shears furnish bed lengths to a fully mechanized cooling bed arranged for automatic control, and at low cost. These are some of the features incorporated on a new CONTINENTAL merchant mill, or they can be added to your present mill.

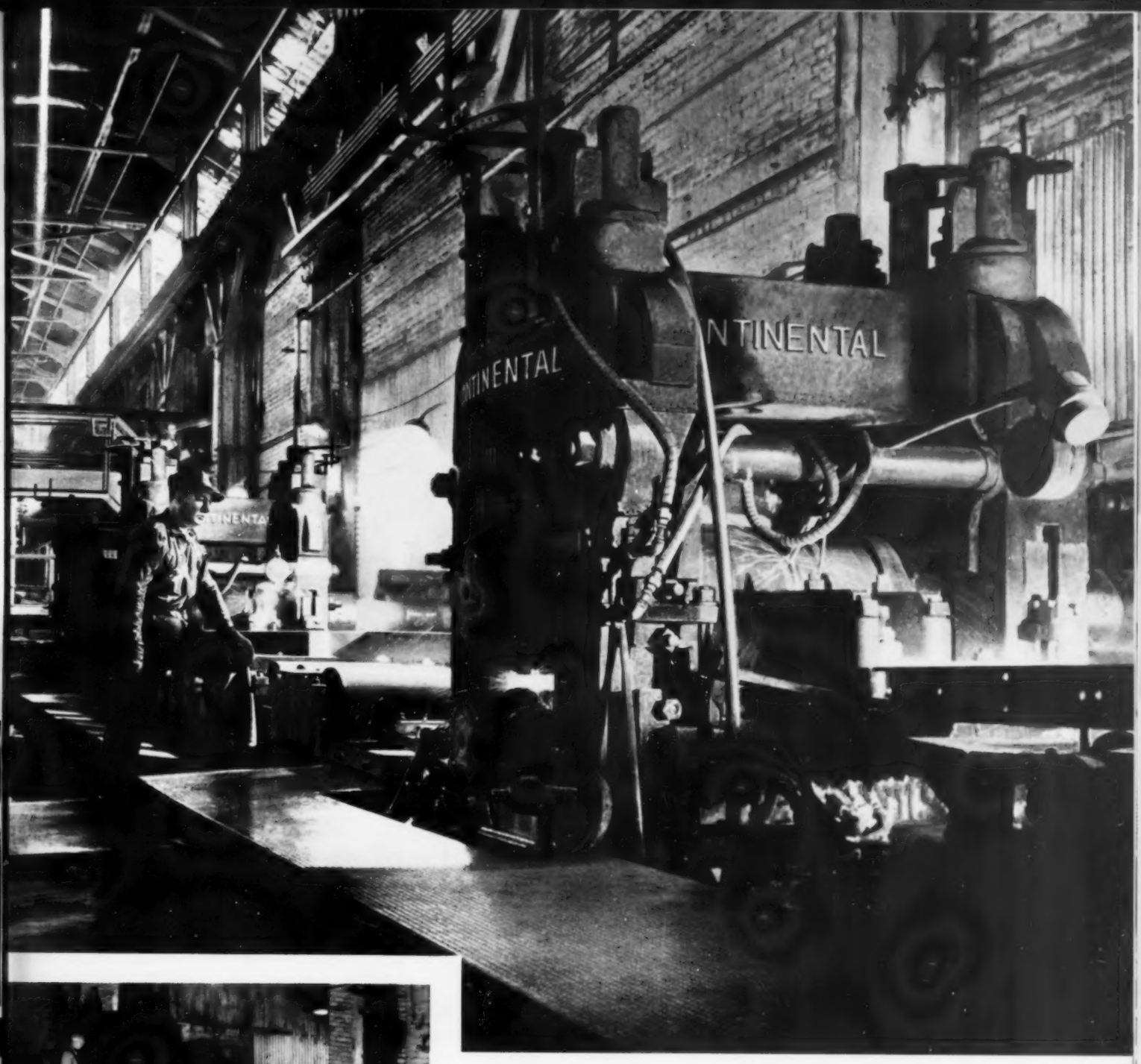
CONTINENTAL makes *all* types of rolling mills for ferrous and non-ferrous metals . . . assumes complete responsibility from preliminary design to final satisfactory operation. And every CONTINENTAL installation is custom designed to meet your specific needs.

NO TONGSMEN NEEDED. Heavy section product is moved from one line of travel to another by means of CONTINENTAL drag-over transfer tables, skew roller tables, and chutes. Automatic bar turners turn the bars up for entry into various stands. Lighter bars are repeated. The end of each bar is automatically prepared for repeating by a CONTINENTAL snip shear.



600-FT. BARS CUT COSTS. Instead of making a great many 200-ft. bars, which would increase handling, scrap, and cost, bars are made in lengths of 600-ft. Each bar is automatically cut off by a CONTINENTAL parting shear in the run-out table. This cooling bed can operate as a notch bar bed or as a flat bed. It can handle irregular sections as well as plain sections.





CONTINUOUS ROUGHING. Two-high stands are used throughout this CONTINENTAL installation. They are much more rigid than three-high mills, give better tolerances in the finished product. A complete range of bar products can be made on this mill, with complete mechanical handling. CONTINENTAL designed the entire installation, including all auxiliaries.

CONTINENTAL

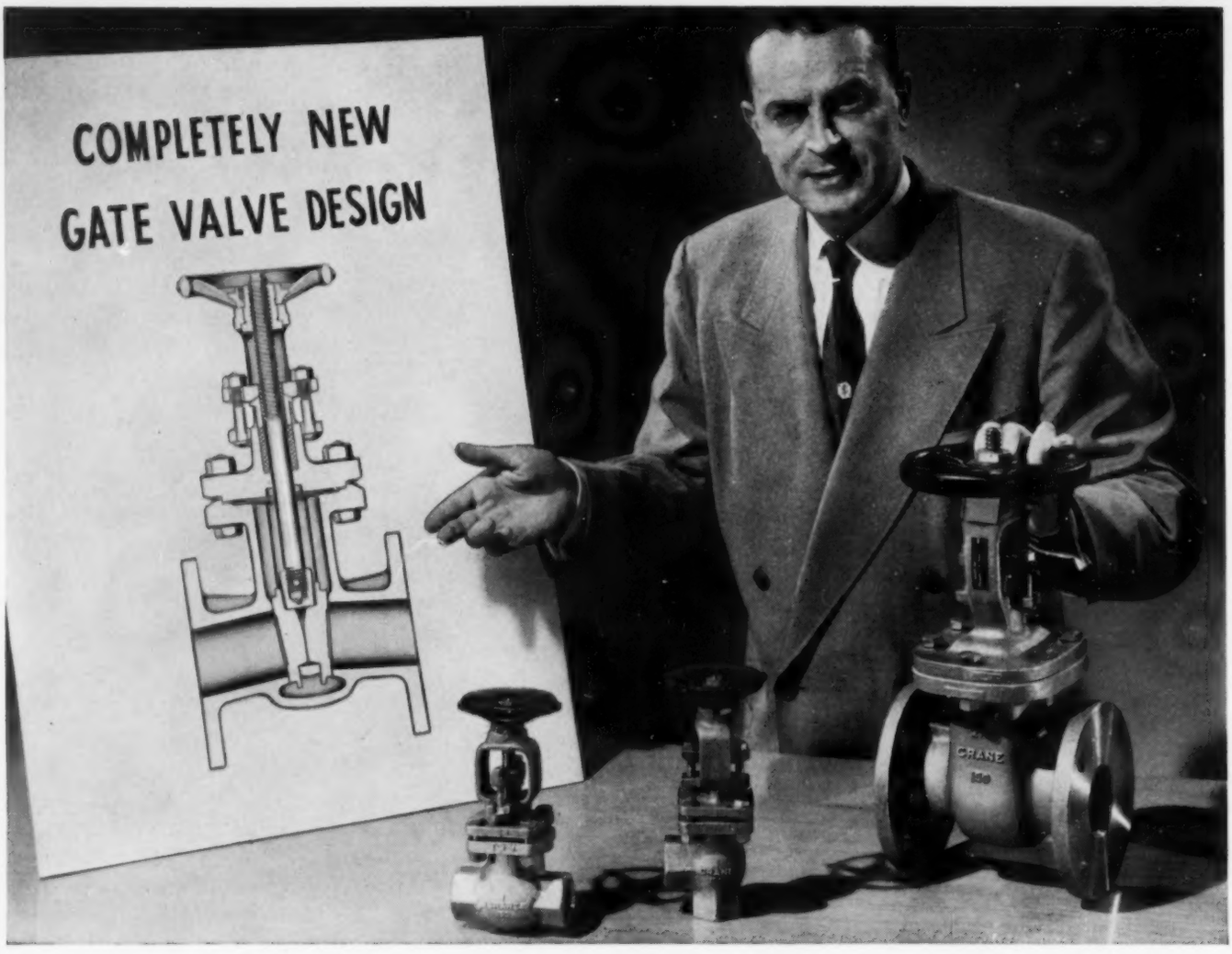
Engineering and Sales Offices
220 Grant St., Pittsburgh 19, Pa.

General Offices
144 Railroad St., East Chicago, Ind.

***Plants at* East Chicago, Indiana, Wheeling, W. Va., Pittsburgh, Pa.**

***Copes-Vulcan Division*, Erie, Pa.**

CONTINENTAL
Foundry & Machine
Company



New CRANE Corrosion-resistant valves in 18-8 SMo and Craneloy 20

Gate, Globe, Angle and Check Patterns

Few valves for process industries have ever received the quality treatment given this new Crane line—at prices you'll find O.K.

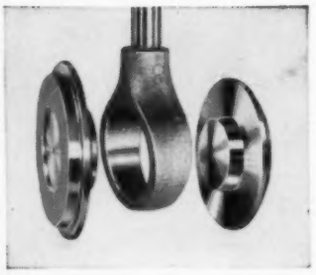
Note, for instance, the unique yet simple split-wedge disc construction in the gate valves. Those dual identical discs are free to rotate in their holder—the most effective design for resisting galling. The trunnion shape at the back of each disc assures even distribution of closing forces. You couldn't buckle them if you tried.

The globe and angle valves give equally outstanding control of corrosive fluids. A new type disc-stem connection, with minimum clearances, practically eliminates vibration. By placing seating load closer to seats, it provides easier, more accurate closure.

Check valves feature compact, thoroughly proved, non-slamming design.

Throughout, these valves are built for better service in your choice of Crane 18-8 SMo Stainless Steel or Craneloy 20. Both lines come with screwed or flanged ends.

ASK FOR THIS CATALOG—Full information including service suggestions given in circular AD-2080—available from your Crane Representative or by mail. Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers everywhere.



New split-wedge disc in gate valves combines the benefits of free rotation with uniform seat load pressure.

for the THRIFTY BUYER

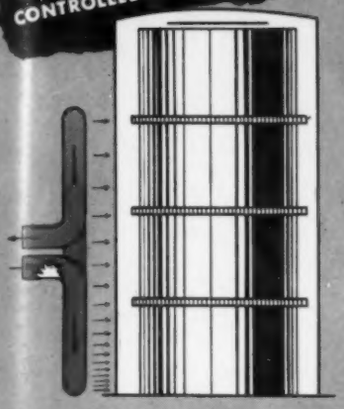
CRANE CO.

VALVES · FITTINGS · PIPE
KITCHENS · PLUMBING · HEATING

CRANE'S FIRST CENTURY...1855-1955

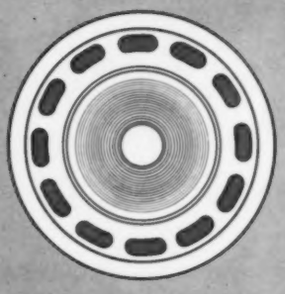
Here's why you can't beat Lee Wilson RADIANT "O" TUBE Annealing Furnaces

CONTROLLED VERTICAL HEAT



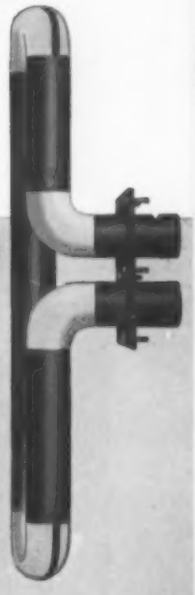
Only the Lee Wilson "O" Tube is able to carry a 500,000 BTU per hour input and disperse it where it can be of most use with major release at the bottom of the tube. An exclusive dual pressure burner permits flame length to be set where required for all ranges of turndown. Thus, the "O" Tube puts the heat where it's needed and gives the operator full control over its vertical release.

UNIFORM HORIZONTAL HEAT



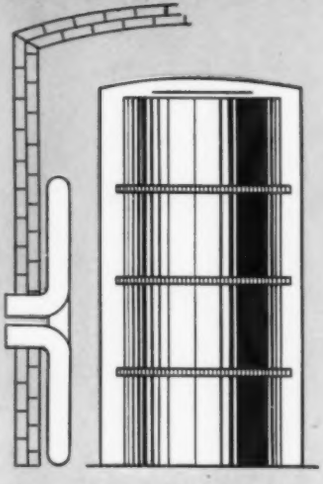
The design of the "O" Tube permits it to be installed in the furnace in a most efficient manner. The tubes completely circle the charge at uniform spacing enabling exacting control of the heat horizontally.

LOW TUBE COST PER TON



"O" Tubes are fabricated of a special heat resisting alloy. Their design gives them a much greater dispersion area which means the rate of heat transfer per square inch is lower than other radiant tubes. The result: tubes last longer — average cost per tube per ton annealed is less than three cents.

LOW MAINTENANCE



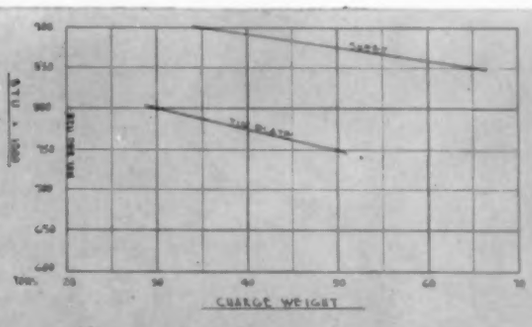
The use of "O" Tubes greatly reduces the cost of furnace maintenance. There's absolutely no chance of a destructive flame burning either the inner cover or the brick work. The uniform heat application around the inner cover prevents inner cover buckling. No holes in furnace arch to give "fallen arches" to the maintenance crew.

After extensive on-the-job testing and cost comparison, we are satisfied the Lee Wilson "O" Tube has no equal as a medium for producing and transferring uniform, high heats for metals annealing. Through the "O" Tube, you are assured of exacting heat control in all parts of the furnace; an efficiency far in excess of that in other types of tubes, and the lowest possible furnace maintenance.

In brief form here we have pointed some of the reasons why the "O" Tube is preferred wherever a thorough comparison is made. Why not ask a Lee Wilson engineer to give you the entire story?

REAL FUEL ECONOMY

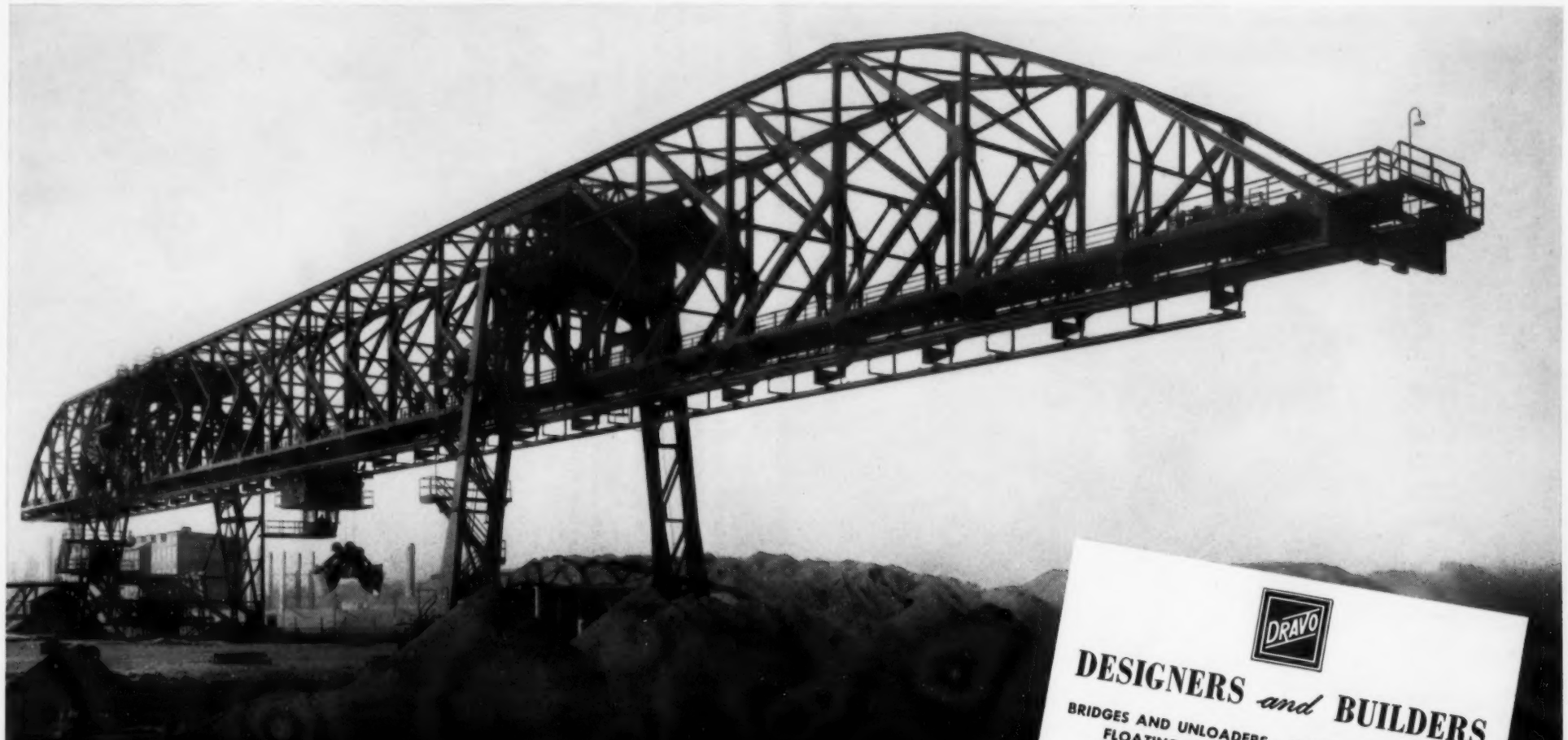
The "O" Tube puts every unit of heat to work. There's no waste. The charge is brought to heat fast — held at heat, economically. On-the-job tests prove the average fuel economy to be 850,000 BTU/ton for sheet coils and 750,000 BTU/ton for tinplate coils.



Recent installation of Lee Wilson furnaces in one of America's leading steel firms. These furnaces are equipped with ten 6-inch "O" Tubes each, with a total input of 5,000,000 BTU per hour.

Lee Wilson ENGINEERING COMPANY, INC.

20005 WEST LAKE ROAD • CLEVELAND 16, OHIO



Ore handling capacity was greatly increased for a large Eastern steel producer when this Dravo designed and built 15-ton ore bridge was installed. As a result of its performance, another 15-ton Dravo ore bridge of similar design was added recently by this user.

Steel plants, power companies, port operators, railroads and other industrial firms are using Dravo heavy materials handling equipment in a wide variety of installations. One of our engineers will arrange for you to visit one of these locations.

There, you can see for yourself the performance, ruggedness and quality which have been engineered into these structures. If interested, phone us at Pittsburgh—the number is SPalding 1-1200.

Bulletin No. 225 describes bridges, unloaders, trolleys, towers and other equipment. Your copy will be mailed on request.

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BRIDGES AND UNLOADERS • TOWER-TYPE UNLOADERS
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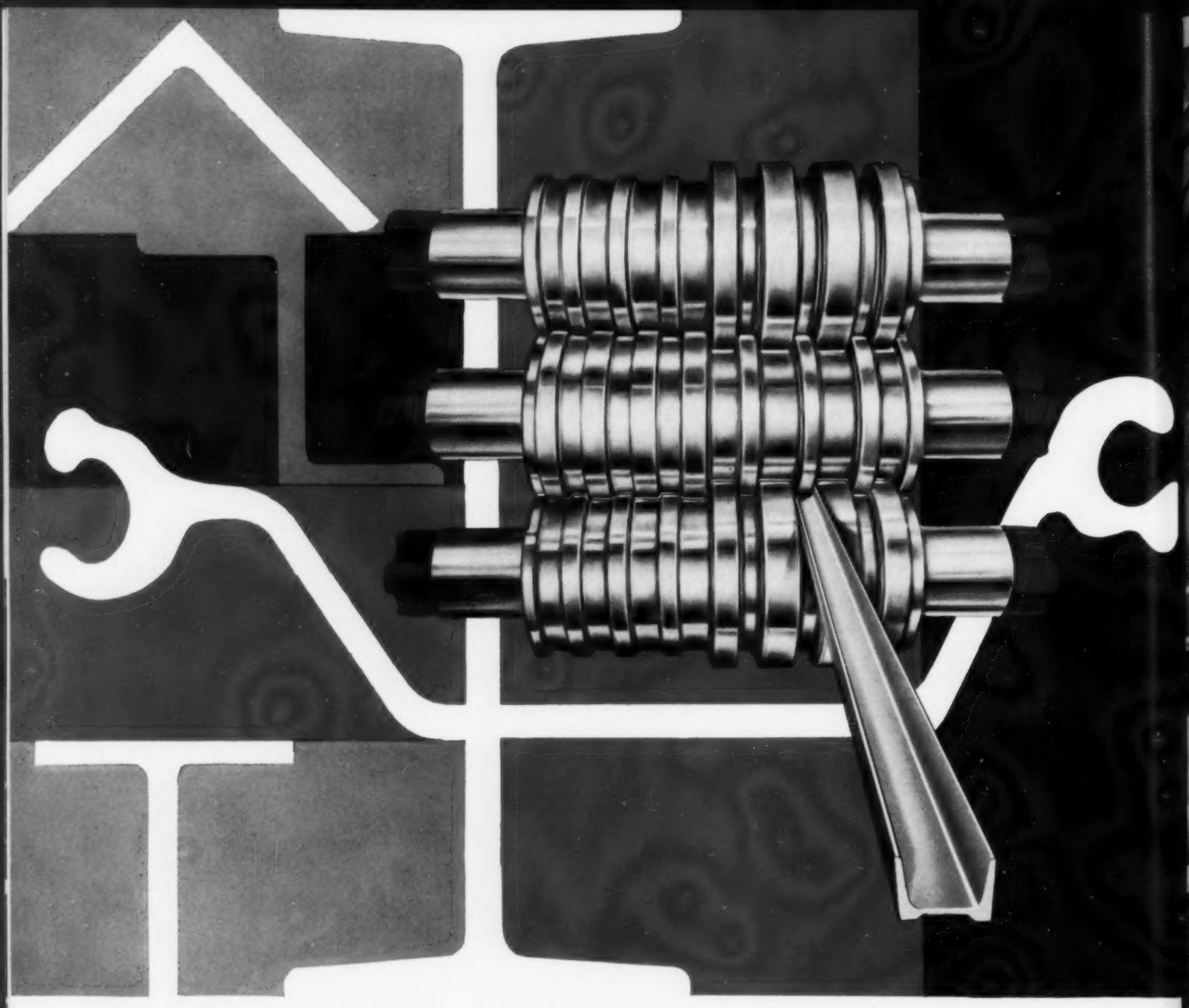
CORPORATION
NEVILLE ISLAND, PITTSBURGH 25, PENNSYLVANIA

Air Conditioning • Boiler and Power Plants • Crane Cab Coolers • Docks • Industrial Foundations • Open Steel Flooring • Pump Houses and Intakes • Space Heaters • Water and Waste Treatment Plants • Towboats and Barges • Sintering and Pelletizing Plants.

For Coiling and Sheeting Applications

Stamco has equipment available in a wide range of sizes and speeds for coiling and sheeting applications in mill, warehouse or factory. These bulletins tell the complete story. Request them by number on your letterhead. No obligation.

STAMCO, Inc., New Bremen, Ohio



High tonnage schedules in structural mills call for the stamina of

MACK-HEMP STRIPED RED WABBLER ROLLS

Skilled operators know from their records that they can depend upon MACK-HEMP Rolls to produce clean, accurate structural shapes on a high production basis. They know, too, that MACK-HEMP keeps in close touch with mill practice developments and with roll designers and mill operators to produce rolls that assure low cost operating.

This is being proved in practice in most prominent mills today, both large and small, by the strong, tough Midland Superalloy Rolls in roughing stands and the wear-resistant Midland Supermetal Rolls in intermediate and finishing stands.

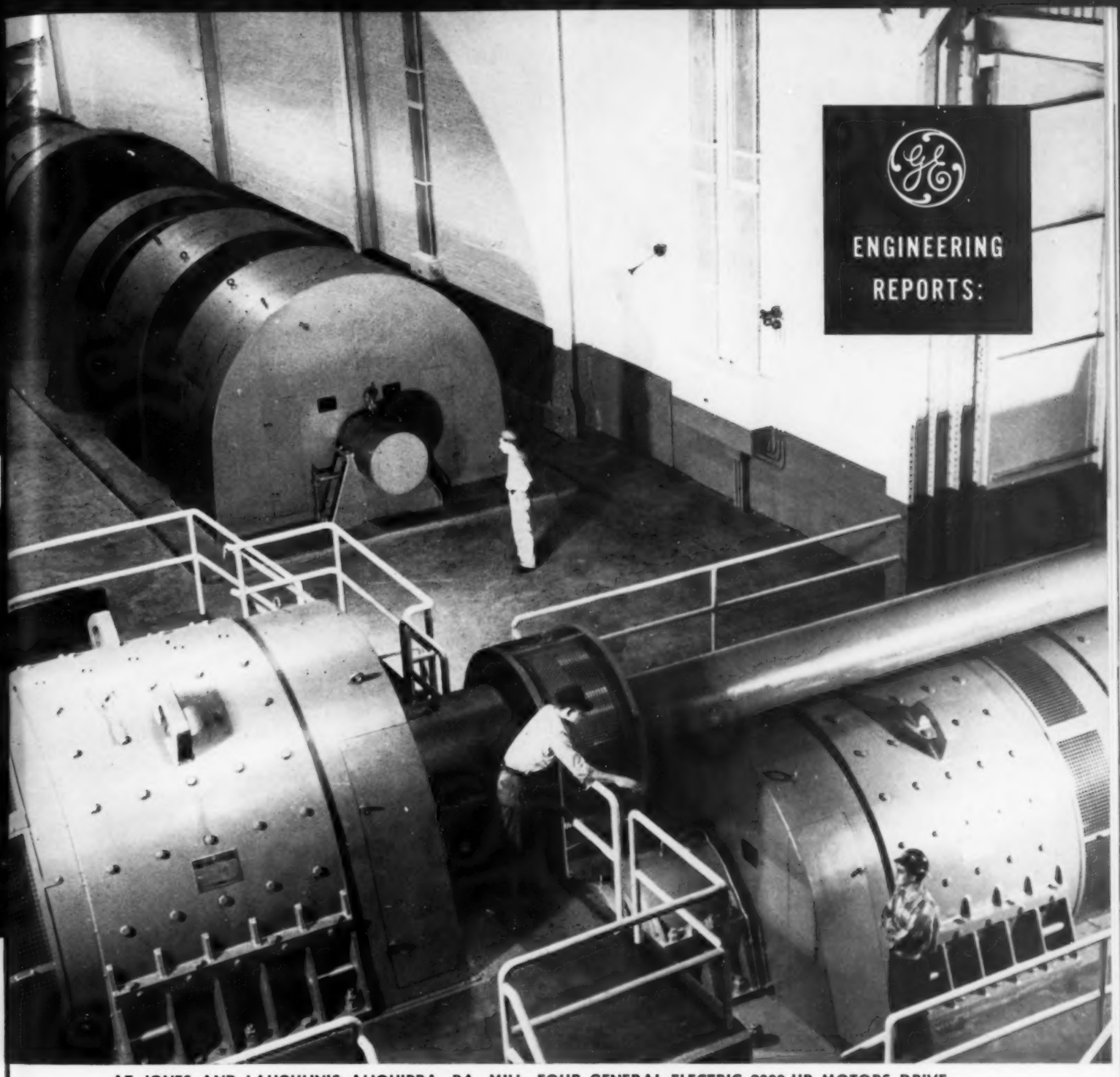
Continuous developments in metallurgical and manufacturing practices make it increasingly worth your while to keep an eye on what's new and different at MACK-HEMP.

MACKINTOSH-HEMPHILL DIVISION · PITTSBURGH-U.S.A. · BLISS

MACKINTOSH-HEMPHILL
DIVISION OF E. W. BLISS COMPANY

Makers of the Rolls with the Striped Red Wabblers **PITTSBURGH AND MIDLAND, PA.**

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: all types of cast mill rolls . . . improved Johnston patented corrugated cinder pots and slag handling equipment . . . Mackintosh-Hemphill rotary straighteners—electronically controlled contouring lathes—screw feed roll turning lathes—heavy duty engine lathes . . . shears . . . end-thrust bearings . . . steel and special alloy castings . . . reversing hot strip mills . . . Y-type cold strip mills



AT JONES AND LAUGHLIN'S ALIQUIPPA, PA. MILL, FOUR GENERAL ELECTRIC 3000-HP MOTORS DRIVE . . .

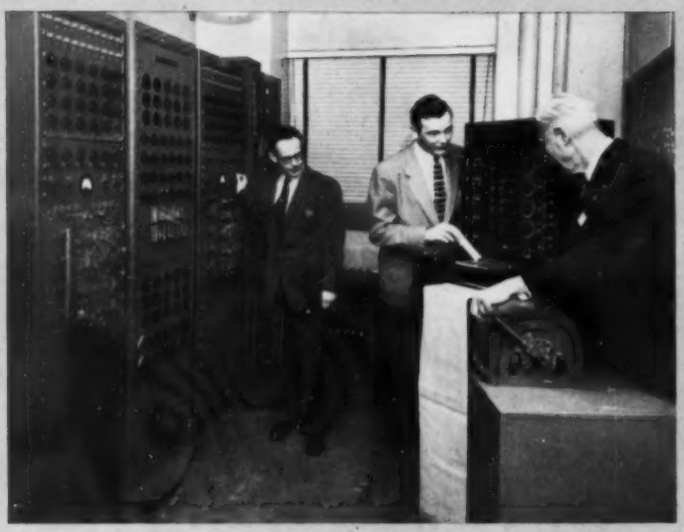
Record-breaking reversing blooming mill

Jones and Laughlin's 44 in. blooming mill at Aliquippa, Pa., has smashed all previous world production records for small ingots. Powered by a coordinated General Electric drive system, this mill which is reversed from 70 rpm to 70 rmp in one second, has rolled 576 ingots in one eight hour shift—a 10 per cent increase over the old record set by the same mill when it was steam-driven.

J&L's conversion from steam to electric drive was an outstanding feat. In only 7 days, 14¼ hours the mill was back in full, around-the-clock production. This was more than two days ahead of the schedule set up for the changeover. For the story of the conversion and how G-E engineering services aided J&L in this operation see the following pages.

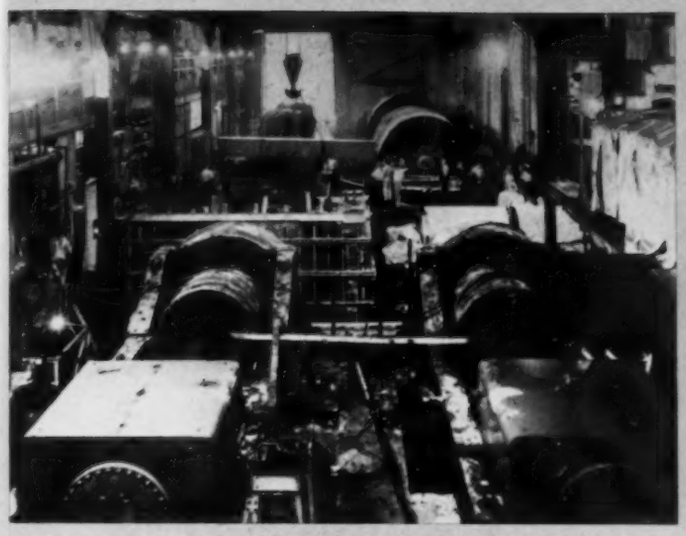
SEE CONVERSION STORY ▶

GENERAL ELECTRIC



GENERAL ELECTRIC engineers pre-determined electric drive system adjustments with electronic differential analyzer, and built wooden scale model of drive to rehearse conversion.

GENERAL ELECTRIC



JONES & LAUGHLIN engineers directed entire conversion, working day and night. Approximately 200 workmen per turn were utilized in the change-over which saw . . .

FULL PRODUCTION RESTORED IN 7 DAYS, 14½ HOURS

To help assure that Jones and Laughlin's conversion from steam to electric drive would be completed within 10 days, and that the new drive would help J&L surpass old production records, General Electric utilized its full range of engineering services.

Working closely with J&L, G-E analytical engineers simulated all operating conditions on an electronic differential analyzer. With G-E product engineers assisting, the design and adjustment of the electrical system were determined after "runs" of the mill on the analyzer were examined. As a result of these computer studies, the drive system was "tailored" to meet the exact requirements of Jones & Laughlin.

To help speed the conversion, a wooden scale model of the 12,000-hp main drive, its foundation and the steam engine foundation was built to study the problems involved in the installation. The model was assembled and disassembled piece by piece as J&L and G-E engineers rehearsed the actual changeover.

More time was saved when the electrical system was designed so that switchgear, m-g sets, exciter sets, control and even ventilating equipment could be installed and tested before the old drive was shut down. G-E field engineers were on hand to assist in the conversion and start-up of the drive.

These G-E engineering services are available to you. They will help save you time and money whether you are planning to modernize, expand, or build. For further information about these engineering services, contact your nearest G-E Apparatus Sales Representative, or send for bulletin GEA-2244. General Electric Company, Schenectady 5, N. Y. 659-106

Engineered Electric Systems for Steel Mills

GENERAL ELECTRIC

DESIGNED TO MEET AISE STANDARDS, a new General Electric single-magnet, two-shoe, direct-current brake is shown installed on a slab depiler at Jones & Laughlin Steel Corporation plant — Cleveland Division. All brake settings are made at one end.

New General Electric d-c brake with single-point adjustment cuts maintenance time at J&L

ONE OF THE FIRST General Electric direct-current brakes with single-point adjustment underwent tests at Jones & Laughlin Steel Corporation's Cleveland Division. On actual rigid application duty J&L found the brake needed a minimum of maintenance and reduced expensive down-time. New design features which won the approval of J&L maintenance personnel are as follows:

ONE EASY ADJUSTMENT with a wrench is all that is needed to correct for lining wear. Even where one lining wears more than the other, a self-centering fulcrum automatically equalizes both shoe clearances.

ARMATURE GAP INDICATOR shows when to make lining wear adjustment. Normal gap position is clearly shown on this readily accessible gage.

SET AND FORGET torque on the new G-E brake, no more adjustments are necessary. Should the brake's rating be changed, torque setting is easily varied to correspond.

BUILT TO AISE STANDARDS the new brake is suitable for both horizontal and vertical mounting under most conditions. It can be right- or left-hand mounted with no change in pins or bolts.

MORE VERSATILE INSTALLATION is possible with the new brake because all necessary adjustments, settings, and connections can be made from one end. This allows the equipment to be mounted within tight space limitations—only one end need be accessible.

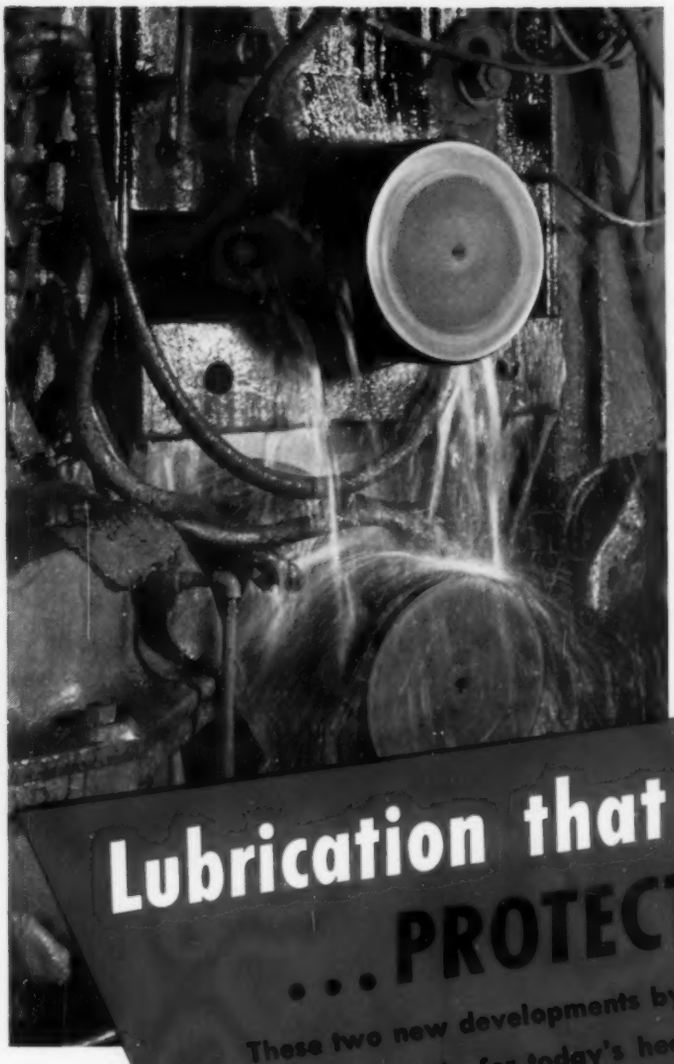
REMOVABLE LININGS can be slipped out with a screw driver after holding bolts are removed—no need to disassemble complete brake shoe.

UNIQUE STRONGBOX MAGNET COIL is easily removable independent of complete magnet assembly. Coil construction seals out dust, moisture, oil, and helps protect windings against mechanical damage.

REDUCE MAINTENANCE and down-time as J&L did—get G.E.'s new d-c brake. For more information contact your nearest General Electric Co. Apparatus Sales Office or send for Bulletin GEA-6214. Section 781-10, General Electric Company, Schenectady 5, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC



multi-purpose
COSMOLUBE E. P. grease

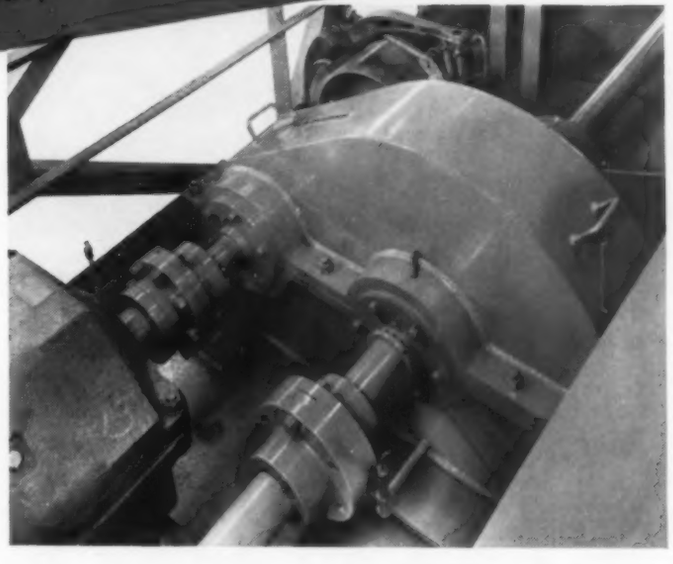
This new type multi-purpose lubricant—Cosmolube E.P. (extreme pressure treated) Grease—combines extra high film strength with unusual resistance to heat, cold and water.

Good example is the rolling mill operation shown. Cosmolube E.P. is withstanding not only terrific pressure in the roll neck bearings but constant dousing as well. This versatile grease *simplifies* lubrication and reduces chance of misapplication because of its wide range of uses.

Try Cosmolube E.P. Grease for any heavy-duty bearing application. You'll find it's especially satisfactory even under hot, cold, or wet conditions.

Lubrication that lasts longer ... PROTECTS BETTER

These two new developments by HOUGHTON meet your needs more effectively for today's heavy-duty, simplified lubrication



heavy-duty
HOUGHTO-GEAR E. P. oils

Developed expressly to meet the lubrication demands of heavy-duty gearing, HOUGHTO-GEAR E.P. (extreme pressure treated) Oils stand up under loads impossible for standard oils.

Gear box shown is typical of the jobs Houghto-Gear E.P. does best. It is *long* lasting—and its durable oily film not only protects gear teeth from wear, but reduces maintenance costs and helps to eliminate production stops for replacement and adjustment.

Available in S.A.E. 90, S.A.E. 140 and S.A.E. 250, this heavy-duty, tough bodied gear oil may be the economical solution to your lubrication problem.

products of

E. F. HOUGHTON & CO.

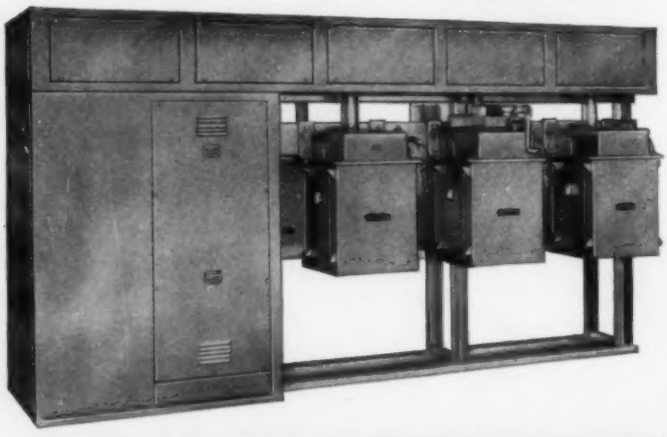
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

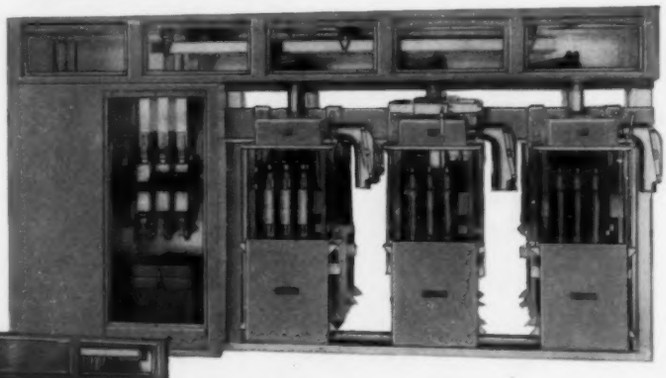
Ready to give you on-the-job service . . .

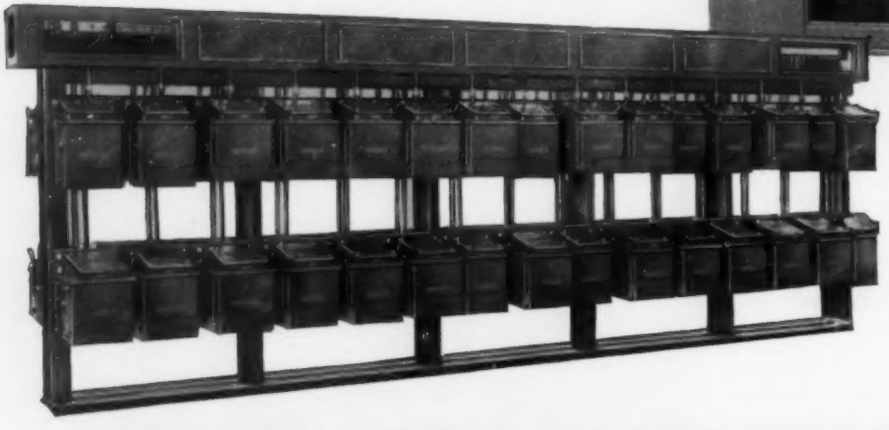
Oil Immersed

LOW VOLTAGE CENTRALIZED CONTROL

Rowan Low Voltage Centralized Control units are designed to meet modern industry's increasing demand for greater centralization of motor control. They consist of bus compartment, bus mounted on porcelain insulators providing liberal spacing, necessary motor starting equipment, auxiliary and pilot devices. Individual control transformers may be installed either in the bus compartment or in the starter. These units are designed for indoor or outdoor service . . . unique construction eliminates the use of gaskets for outdoor service.







ABOVE — Closed view and open view of a Centralized Control unit showing Disconnect Switches with incoming line circuit breaker for an outdoor application.

LEFT — Closed view of a Centralized Control unit showing Frames 50 and 100, 780-KBF Starters, mounted on a sturdy steel structure.

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

4-HIGH 6-STAND CONTINUOUS HOT STRIP MILL

(OPERATING IN WALES)

DESIGNED AND BUILT BY

UNITED

ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at PITTSBURGH • VANDERGRIFT • NEW CASTLE • YOUNGSTOWN • CANTON

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Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments.

UNITED can serve you no matter where in the world you are.

UEFCO ®

Bailey Recorder for receiving pneumatic and electric signals.

Pick any four, plug in, and record

Here is a receiver recorder, custom-built *by you* to meet your needs, no matter how changeable, how complex. On a single chart you can record any four measured variables—and interchangeable receivers permit new combinations almost at will.

Individual plug-in pneumatic or electronic receivers—and corresponding integrators—are interchangeable in the four identical frame slots. You can select any combination; even including two receivers and their two integrators.

Think what this can mean to you! Parts inventories are minimized; re-use of components keeps instrumentation costs economically low when cycle changes are frequent—and you can even tie in with your existing transmitters.

Ask for Product Specification E12-5.

Measured Variables

- % combustibles
- combustion
- conductivity
- density
- differential
- draft
- flow
- liquid level
- % oxygen
- pH
- position
- pressure
- ratio
- smoke density
- specific gravity
- speed
- temperature
- vacuum

P33-1

ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER

- Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
- A full year's ink supply at one loading
- Faster ordering—from stock
- Minimum inventory of parts
- Minimum instrument investment for process cycle expansion or alteration

BAILEY METER COMPANY

1047 IVANHOE ROAD

CLEVELAND 10, OHIO

Controls for Power and Process

BAILEY METERS

Controls for

TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW · LEVEL
RATIO · DENSITY

The choice of leading mills for back-up roll bearings

. . . GULF I-C OIL

Several years ago Gulf I-C Oil was selected to lubricate the back-up roll bearings of the world's fastest cold strip mill at U. S. Steel's Fairless Works. Today it is still doing an outstanding job of providing effective protection as the strip shoots through the rolls at speeds up to 7000 feet per minute.

Gulf I-C Oil has excellent stability, resists emulsification and sludging, plus rapid water separating characteristics. These properties keep bearings and oil lines clean, contribute to longer bearing life, trouble-free performance, and lower maintenance costs.

So when you next order a roll-bearing lubricant, make it an order for dependable, efficient lubrication by specifying Gulf I-C Oil. Contact your nearest Gulf office and have a Gulf Sales Engineer recommend the proper grade for your equipment. Gulf Oil Corporation · Gulf Refining Company, 1822 Gulf Building, Pittsburgh 30, Pa.

GULF

THE FINEST PETROLEUM PRODUCTS FOR ALL YOUR NEEDS

Principal plant of Dutch State Mines whose processes for producing NH_3 from coke oven gas are now available in equipment manufactured by Air Products, Incorporated.

NOW-Convert Coke Oven Gas to NH_3

BY

TIME TESTED METHODS

Air Products, Incorporated, has concluded an exclusive arrangement with Dutch State Mines of Holland for the exchange of technical know-how in the purification of coke oven gas to produce synthetic ammonia.

Dutch State Mines is one of the world's principal manufacturers of synthetic ammonia from coke oven gas. It is prominent internationally for its activities in designing, building and operating low-temperature processing equipment for this purpose.

Air Products, for many years, has constructed units for many types of gas separations. These include refinery gases, reformed gas streams, and others for the production of ammonia synthesis gas. The design of Air Products equipment for the low-temperature purification of coke oven gas is based upon American chemical engineering practices and also takes advantage of the process design and operating experience which has been developed over a period of 25 years in the laboratories and operating plants of the Dutch State Mines.

LOW COST OXYGEN...NITROGEN

Air Products
INCORPORATED

Dept. P, Box 538, Allentown, Pa.

Patent Reviews

By MELVIN NORD
Patent Attorney
Detroit, Mich.

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each . . . . patents reviewed cover period January 25, 1955 through February 22, 1955 . . . .

INTEGRATED CYCLIC PROCESS FOR PRODUCING METALLIC IRON FROM IRON ORE

▲ U.S. 2,701,761, and 2,701,762 issued Feb. 8, 1955 to Henry L. Crowley, and assigned to Henry L. Crowley & Co., Inc., describes a process for producing metallic iron in powder form from ores which may be low in iron content, and which does not involve melting the gangue.

The process consists of the following basic steps: (1) subjecting the ore to chloridizing with HCl gas, thereby converting the iron oxides to ferrous chloride, (2) vaporizing the ferrous chloride, in order to separate it from the solid gangue, (3) reducing the ferrous chloride, either as vapor (U.S. 2,701,761) or as liquid (U.S. 2,701,762) with hydrogen gas, and (4) separating the resulting iron powder from the other materials present which are then recycled to the process (e.g. $FeCl_2$, H_2, and HCl).

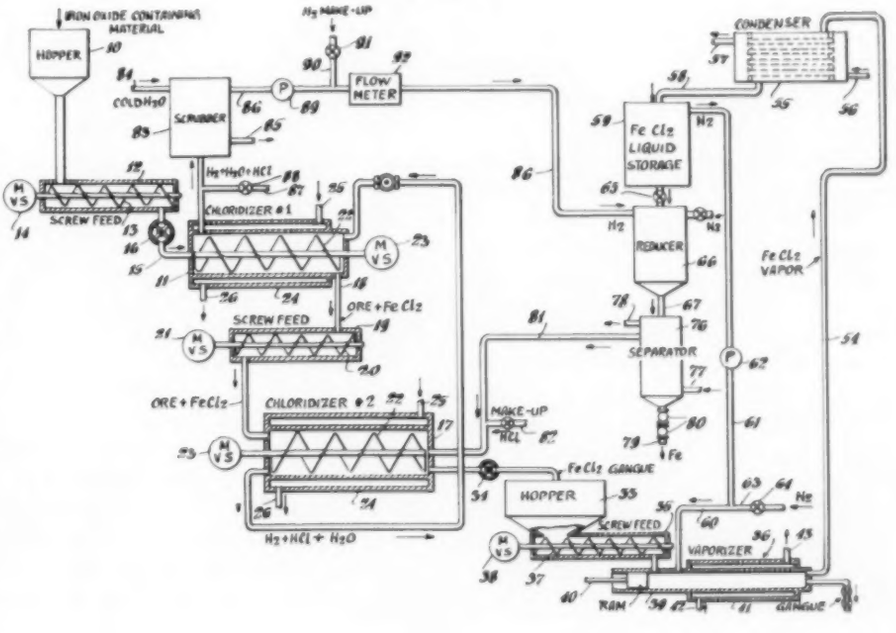
A number of ways of carrying out the process are described in the two patents, one of which is shown in Figure 1. The raw material shown entering the hopper 10 may contain iron oxide in any of its forms, i.e. Fe_3O_4, Fe_2O_3, or FeO, together with gangue components which do not form volatile chlorides. According to the patent the concentration of iron in the ore is not particularly important, since the gangue is not melted and therefore there is no great increase in the heat requirement as the percentage of gangue is increased. The ore is preferably 50 mesh or finer in particle size, in order to provide good contacting with the chloridizing gas.

The raw material is fed from the hopper 10 at a controlled rate into a first chloridizer 11 and subsequently into a second chloridizer 17. In each chloridizer, the solid material is advanced and agitated by a helical screw 22 which is driven by a variable speed motor 23. Surrounding each chloridizer is a heating jacket 24. In starting up the apparatus, it is necessary to bring the temperature of the solid material in the chloridizers up by the addition of heat, but after the reaction is started this is no longer necessary as the reaction is exothermic.

The chloridizing gas must contain HCl and hydrogen, and it may also contain other inert ingredients. The hydrogen is required in order to reduce iron in the trivalent state to the divalent state, so that the product of the chloridization will be $FeCl_2$.

The temperature in the first chloridizer is about 500 to 800 F, and in the second 800 to 1200 F. The chlor-

Figure 1



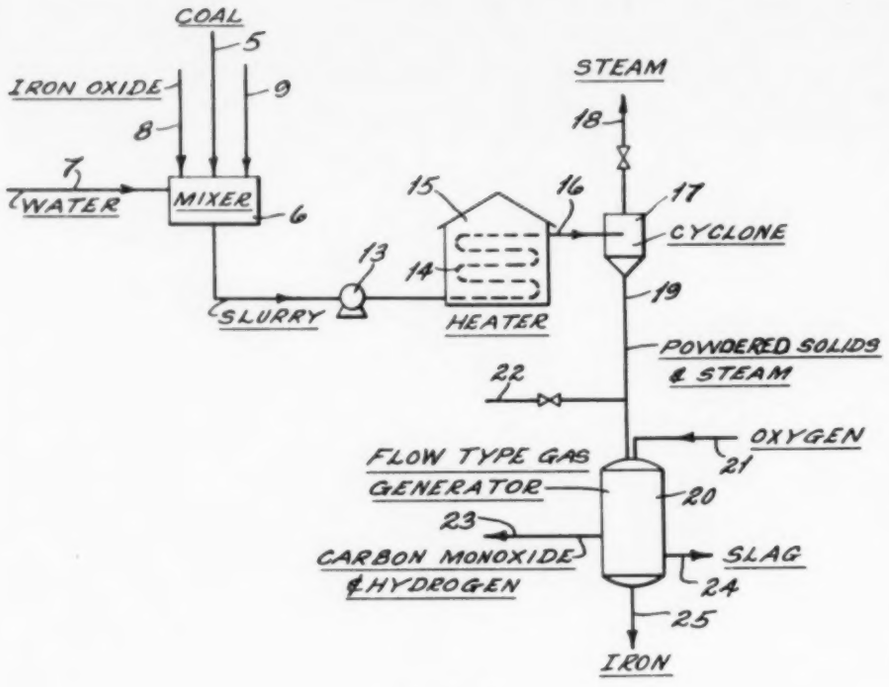


Figure 2

idizing gas passes through the chloridizers, countercurrent to the flow of solids, so that effective heating and contacting is obtained.

The solid material leaving the second chloridizer goes to a hopper 33, preparatory to being fed to a jacketed vaporizer 36. An inert gas such as nitrogen may be added in order to aid in the vaporization of $FeCl_2$, by lowering the partial pressure of $FeCl_2$ required for its vaporization.

In the method of operation shown in Figure 1, the $FeCl_2$ vapor, together with nitrogen, passes to a condenser 55, in which the $FeCl_2$ is condensed to the liquid state, the nitrogen being recycled to the vaporizer. The liquid $FeCl_2$ is collected in a storage chamber 59 and is then fed to a heated reducer 66, where it is contacted with hydrogen. The materials leaving the reducer 66 include powdered iron, unreacted $FeCl_2$, unreacted hydrogen, and HCl formed in the reaction. In the method of operation shown in Figure 1, the temperature in the reducer is kept high enough so that any unreacted $FeCl_2$ leaves as vapor. Therefore, the powdered iron can be separated from the other materials by means of a solid-gas separator 76, such as a cyclone separator. The gases separated are recycled to the second chloridizer.

In order to complete the cycle, the disposition of the exit gases from the chloridizers must be explained. These gases contain unreacted hydrogen and HCl, as well as water vapor formed during the reaction with the iron oxides. The gases are cooled and scrubbed in a scrubber 83 through which cold water is passed. Practically all the unreacted HCl is removed in the exit water stream from the scrubber, and most of the water vapor is condensed out. The remaining gas, which is essentially all hydrogen, is sent to the reducer 66, where it converts the $FeCl_2$ to iron.

PRODUCTION OF PIG IRON AND CO-H_2 GAS

U.S. 2,702,240, issued Feb. 15, 1955 to Harry V. Rees and Frederick B. Sellers, and assigned to Texaco Development Corp., describes a process for producing pig iron from iron ore and coal, and simultaneous gasification of coal by reaction with steam and oxygen to produce carbon monoxide and hydrogen.

As shown in Figure 2, crushed coal is introduced through line 5 into a mixer 6. Sufficient water to form a fluid dispersion is admitted to the mixer through line 7. Iron oxide is supplied to the mixer through line 8. Additive materials, e.g. a flux, oxidation catalyst, a deflocculating agent, wetting agent, etc., may be added to the mixer through line 9. The resulting slurry is passed to a pump 13 and then to a tubular heater 14, in which the slurry is heated to 1000 F. The water in the slurry is vaporized, and the resulting dispersion of solid particles in steam passes into a cyclone separator 17. A portion of the steam is separated here, the remaining steam and solids going to a flow-type gas generator 20. Preheated oxygen (or oxygen-rich gas) is supplied through line 21. Some powdered solid may be removed through line 22 for recycle to the mixer 6 as an aid in making up the slurry.

The generator is operated at about 2900 F and 220 psig. A gaseous product consisting mainly of carbon monoxide and hydrogen is discharged through line 23. Molten slag is drawn off through line 24, and molten iron through line 25.

The gas produced, after washing, has a heating value of 300 Btu per cu ft. The pig iron produced has about the same composition as pig iron produced in the blast furnace.

BED FOR FOAMING BLAST FURNACE SLAG

In U.S. 2,700,849, issued Feb 1, 1955, Gunter A. Klotzbzch describes a bed for the foaming of molten blast furnace slag, in which the bottom of the bed is composed of individual elements which can individually be exchanged without affecting the water nozzles. The patent is assigned to Huttenwerk Rheinhausen A. G.

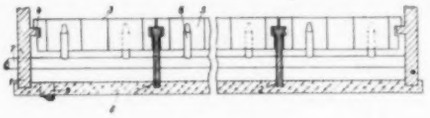


Figure 3

As shown in Figures 3 and 4, the foaming bed is provided with side walls 1 and webs 2. Grate bars 3 are supported on the heads of the webs and on projections 4 on wall 1, forming a continuous bottom for the bed. Passages 5 are provided between the edges of the grate bars, to permit the entry of nozzles 6. The nozzles are connected to a water supply pipe 7. The foaming bed is closed at the bottom by a pan 8 which is filled with porous foamed slag up to the upper surface of the grate bars. The pan is provided with an outlet pipe 9.

Prior to the foaming process, the foaming agent (water) is supplied through the pipes 7 and nozzles 6 in a sufficient quantity to fill the cavities in the filling of the pan. This quantity of water is immediately available at the start of the foaming

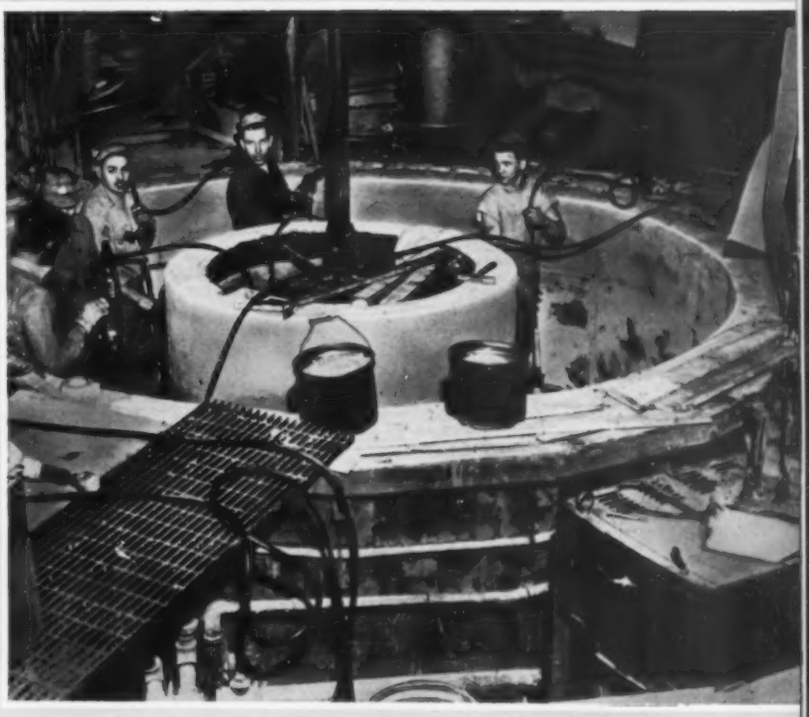
NEW B&W MULRAM 3200 degree Refractory Ramming Mix

More than two years service under tough conditions of slagging and metal penetration have proved the economy of B&W's new ramming mix, Mulram. Used to form monolithic refractory structures, B&W Mulram, which has a crushed fused-mullite base, is recommended for temperatures up to 3200 F. Its combination of low porosity and permeability, when installed, give Mulram the highest possible resistance to metal or slag penetration.

Not only is Mulram's permeability low, but it actually decreases from the hot face to the cold face. This means an *increasing* resistance to penetration through the thickness of the lining. Standard firebrick, on the other hand, have a higher and constant permeability through their thickness.

This combination of maximum resistance to slag and metal penetration and the 3200 F use limit are the chief reasons why B&W Mulram has given superior service in applications like these:

- **Barium chloride salt bath furnaces**
- **Linings for indirect-arc electric furnaces melting iron, steel or non-ferrous metals**
- **Forehearths or holding ladles for gray and malleable iron**
- **Runners and slagging basins on continuous cupolas**
- **Crucible furnace walls.**



B&W Mulram is being rammed into the bottom of this salt bath furnace. Furnace walls are formed with B&W Mulram, backed up by B&W's 3000 degree castable, Kaocast, and insulated with B&W K-20 Insulating Concrete Mix.

Even when penetration is not a serious problem, B&W Mulram often proves economical in such applications as burner blocks or burner tunnels because of its volume stability and high hot-load strength after proper firing. Standard Mulram is made in 4-mesh size, wet or dry form (Mulram 4W and 4D). Other mesh sizes are available for special applications. Call or write your local B&W Refractories Engineer for complete information.

B&W REFRACTORIES PRODUCTS: B&W Allmul Firebrick • B&W 80 Firebrick
B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars
OTHER B&W PRODUCTS: Stationary & Marine Boilers and Component Equipment
Chemical Recovery Units • Seamless & Welded Tubes • Pulverizers • Fuel Burning Equipment
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B&W

R939

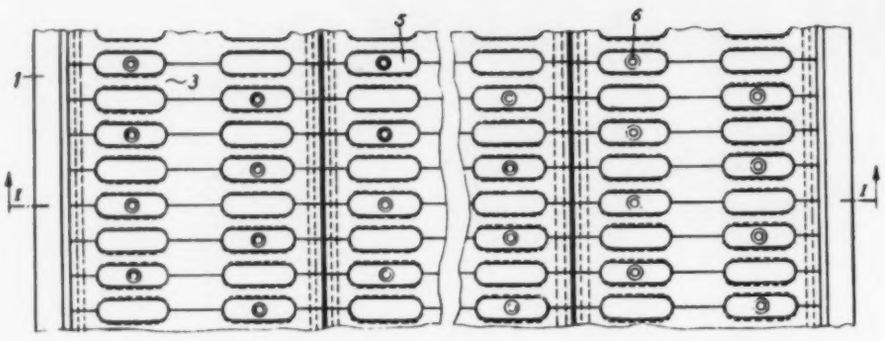


Figure 4

process. During the foaming process, more water is supplied through pipe 7 to the required extent. At the end of the foaming process, after the supply of water has been shut off, the outlet pipe 9 is opened and the excess water is discharged.

METHOD AND APPARATUS FOR MAKING LIGHTWEIGHT SLAGS

In U.S. 2,702,407, issued Feb. 22, 1955 to Fred Osborne, a method is described in which no moving equipment is required in the actual production of the slag, and which produce expanded slag suitable for aggregate in concrete blocks. The apparatus described can handle the full stream of slag produced from a medium size furnace.

As shown in Figure 5, molten slag is poured from a trough 11 over a pouring lip 12 into a trough-like member 16. At the rear of the falling stream of slag are a number of steam nozzles 23. The steam impinges on the slag stream, disrupting its continuity and driving it forward in the form of compact globules towards a baffle plate 36. Before the globules of slag reach the baffle plate, they are contacted by a stream of atomized water from other nozzles (with water inlet 28 and air inlet 33). The expanded slag hits the baffle plate, then falls onto a conveyor 37 and is removed. Water vapor and steam leave through a vent stack 38.

According to the inventor, the expanded slag so produced is high in crushing strength. In addition, very little dust is formed.

APPARATUS FOR IDENTIFYING OPPOSITE SIDES OF A MOVING STRIP

U.S. 2,701,356, issued Feb. 1, 1955 to William E. Coleman and assigned to United States Steel Corp., describes an apparatus for indicating whether or not one side of a steel strip is properly roughened with respect to the other side and whether or not the correct weight of coating is being applied to the opposite sides of the steel strip in an electrolytic tinning line.

OPEN HEARTH FURNACE CONTROL

U.S. 2,702,605, issued Feb. 22, 1955 to Strickland Kneass, Jr., and assigned to Morgan Construction Co., describes apparatus for controlling the flow of gases from furnaces of the regenerative type such as open hearths, and for cleaning the gases before discharge.

The gas is withdrawn from the regenerators and delivered to the gas cleaner by means of an ejector including a nozzle through which cool air is discharged into the gas to cause the desired gas flow and to reduce the temperature of the gas before it enters the gas cleaner. The rate of air supply to the nozzle can be varied as required to control the furnace pressure. A second ejector withdraws the cleaned gas from the gas cleaner.

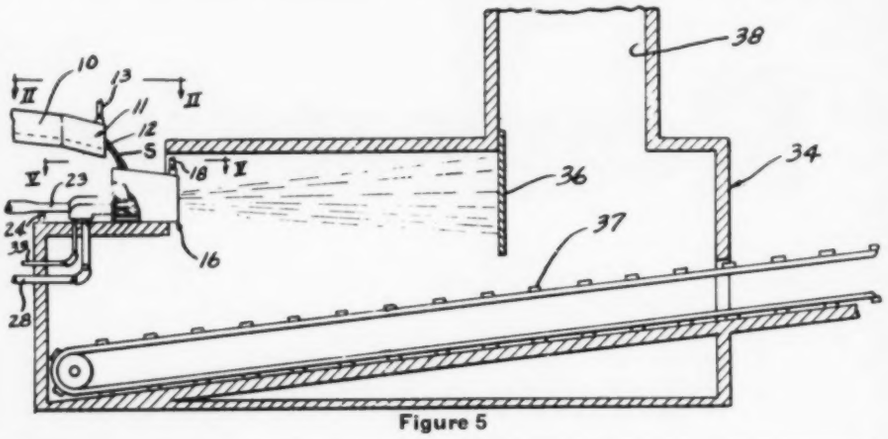
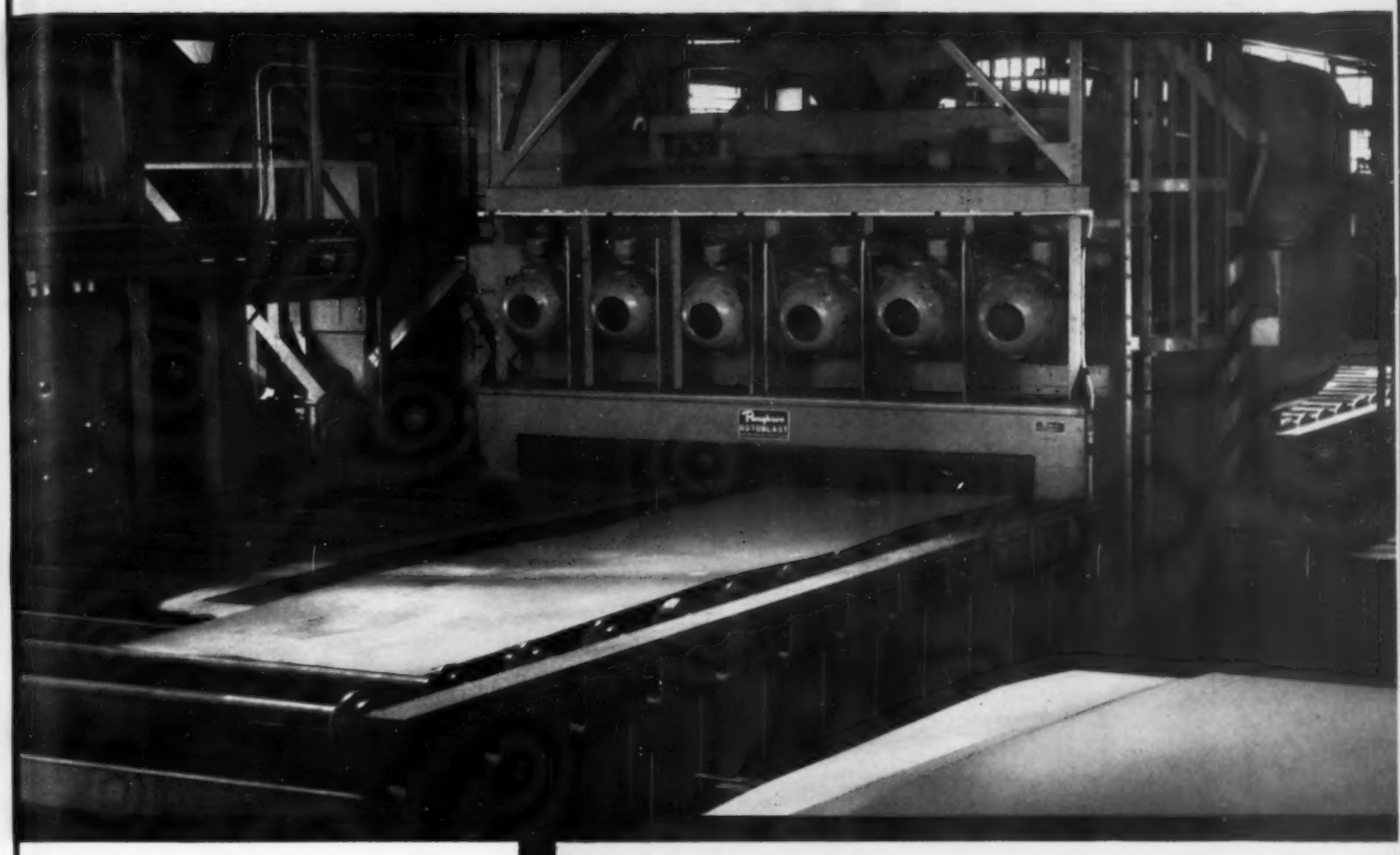


Figure 5

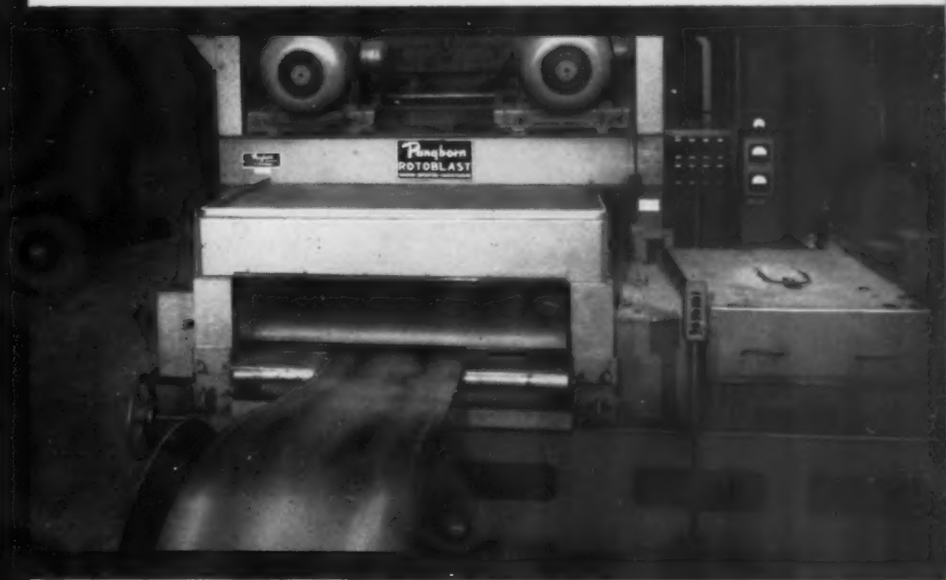
OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,700,314	1/25/55	Machine for knurling metal wire stock	Armco Steel Corp.
2,700,451	1/25/55	Line-shaft roller conveyor with shiftable bearings	United States Steel Corp.
2,700,514	1/25/55	Apparatus for coiling wire	United States Steel Corp.
2,700,692	1/25/55	Electrode clamp for electric furnaces	Republic Steel Corp.
2,700,813-4	2/ 1/55	Conical ball separating means for ball rolling machines	Armco Steel Corp.
2,700,907	2/ 1/55	Strip guide	Metals & Controls Corp.
2,700,908	2/ 1/55	Ball forming die	Armco Steel Corp.
2,700,909	2/ 1/55	Continuous method and apparatus for making grinding balls	Armco Steel Corp.
2,701,016	2/ 1/55	Rotary flying shear mechanism for rod rolling mills	Blaw-Knox Co.
2,701,057	2/ 1/55	Concentration of iron ores by froth flotation	Ballard H. Clemmons
2,701,066	2/ 1/55	Cover operating mechanism for cupola charging apparatus	Modern Equipment Co.
2,701,430	2/ 8/55	Roll assembly for automatically centering a moving strip	United States Steel Corp.
2,701,443	2/ 8/55	Combined supercharged blast furnace and gas turbine plant	Societe Rateau et al
2,701,485	2/ 8/55	Draw roll blank gripping apparatus	A. O. Smith Corp.
2,701,712	2/ 8/55	Bright annealing furnace	C. I. Hayes, Inc.
2,702,320	2/15/55	Contact roll construction	Allegheny Ludlum Steel Corp.
2,702,738	2/22/55	Preparation of ferrous chloride from mixed chlorides of iron and nickel	Republic Steel Corp.
2,702,766	2/22/55	Processing strip material through treating units	Scovill Manufacturing Co.

Descale steel sheets, plates, coils



at *less than half the cost*



No more scale breaking or pickling! No more acid disposal problems! Pangborn Rotoblast Descaling Machines descale steel sheets, plates and coils, and they operate at big savings over pickling costs!

How? They work quickly. They clean thoroughly. They're a one-man operation. Unlike acid baths, they can be located near your production, cutting handling costs. And they save floor space, require much less room than vats. Available in a variety of models, Pangborn Rotoblast Descaling Machines handle steel sheets, plates and coils of any thickness, width and length. If you want to cut descaling costs to the bone, investigate Pangborn Descaling Machines!

For complete information, send for Bulletin 224. Write: PANGBORN CORPORATION, 4400 Pangborn Blvd., Hagerstown, Maryland.

*U. S. Pat. #2184926 (other patents pending)

with Pangborn Rotoblast® Descaling Machines!

Pangborn

BLAST CLEANS CHEAPER

Rotoblast Blastmaster® & Continuous-Flo Barrel

Rotoblast Tables & Table-Rooms

Special Blast Rooms & Cabinets

Pangborn Dust Control Equipment

Malleabrasive® Shot & Grit

BLAST FURNACE

Designed and built by Arthur G. McKee & Company

IN THE COURSE of fifty years of engineering and construction for the Iron and Steel Industry, McKee has completed sixty-four new blast furnaces and rebuilt fifty others.

The performance of these furnaces can be judged best by their consistently long campaigns, particularly in the high-production period during and since World War II. Another indication of their performance is the fact that all but one of the modern records for one month's pig-iron production, including the present record, were made in furnaces of McKee design.

The most recently completed McKee-built furnace, shown on the opposite page, is the largest merchant iron blast furnace in the world.

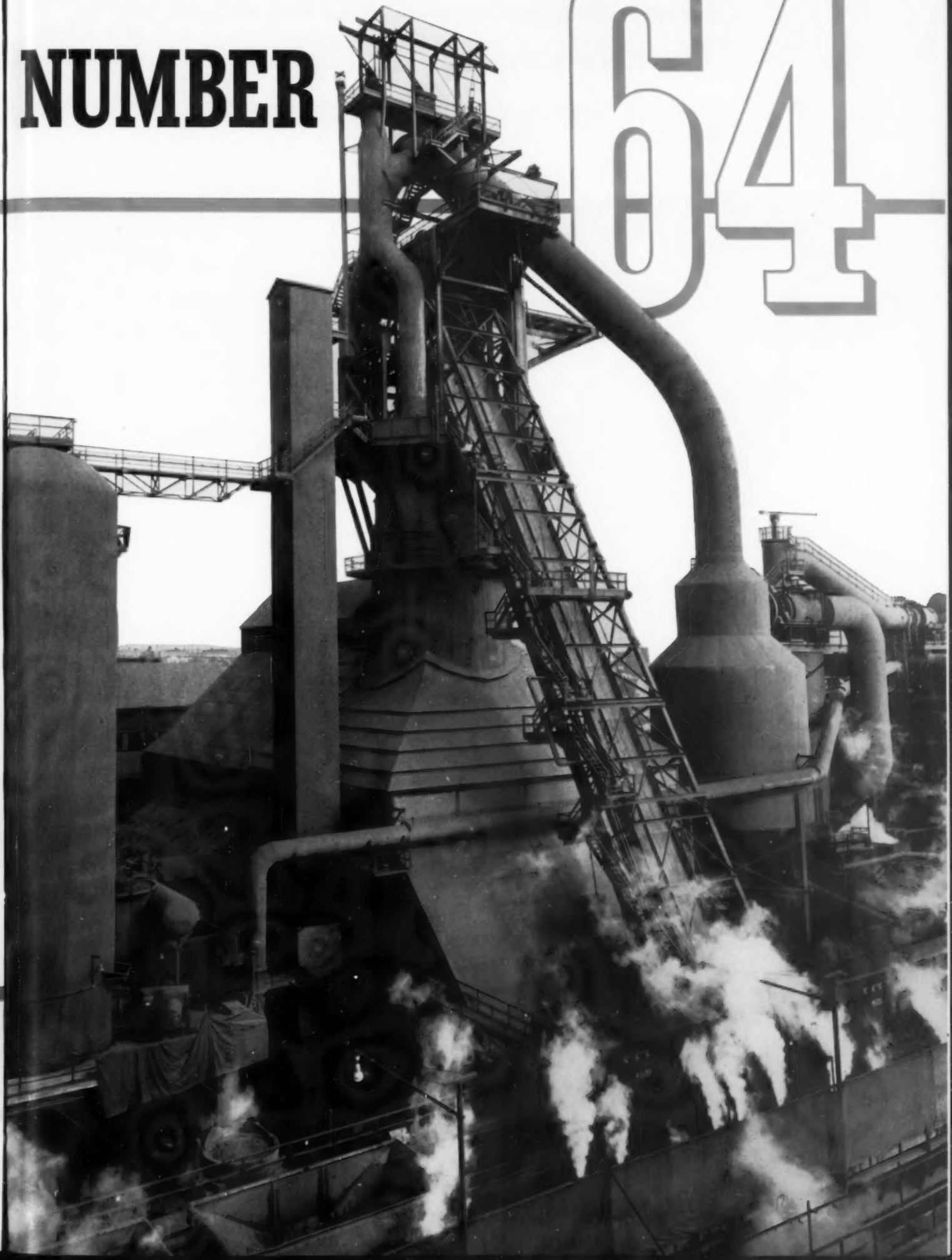
50th ANNIVERSARY

McKee Engineering Services

Arthur G. McKee & Company • Engineers and Contractors

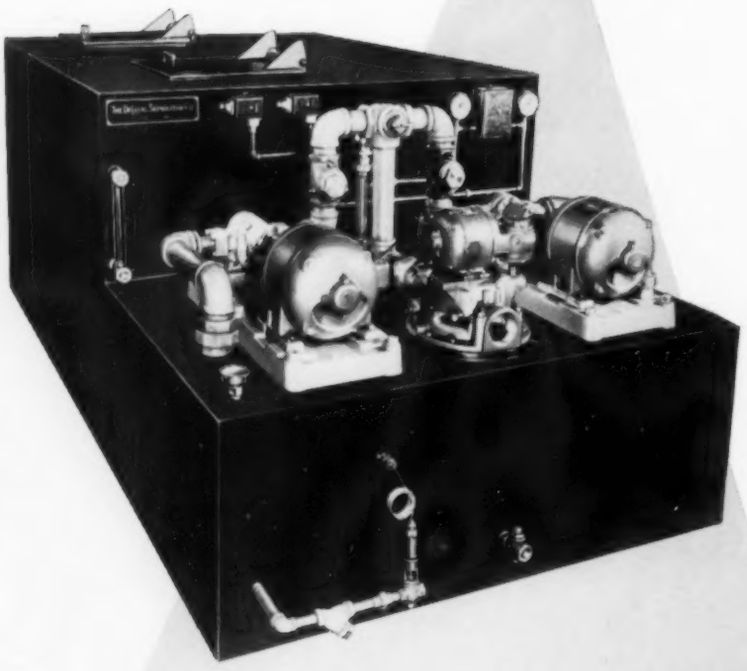
Headquarters: McKee Building • 2300 Chester Avenue • Cleveland 1, Ohio
Offices: New York • Tulsa, Oklahoma • Union, N. J. • Washington, D. C.
British Representatives of Metals Division: Head, Wrightson & Co., Limited
Canada: Arthur G. McKee & Company of Canada, Ltd., 372 Bay St., Toronto

CE NUMBER 64



compact, economical lubrication for the smaller mill...

DE LAVAL UNILUBE SYSTEM



The De Laval Unilube System gives smaller mills all the advantages that De Laval *Custom-engineered* Systems provide for the largest plants.

Completely assembled and ready for operation with minimum installation cost—a De Laval Unilube "packaged" system provides metered streamline flow to bearings and gear mesh points . . . with automatic full-flow pressure filtration . . . and automatic temperature control.

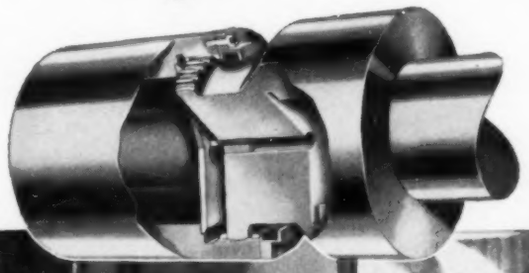
De Laval Unilube units are available in four types —with capacities of 1 gpm to 50 gpm, over the full range of viscosities.

Write for complete details.

DE LAVAL
unilube mill lubrication systems

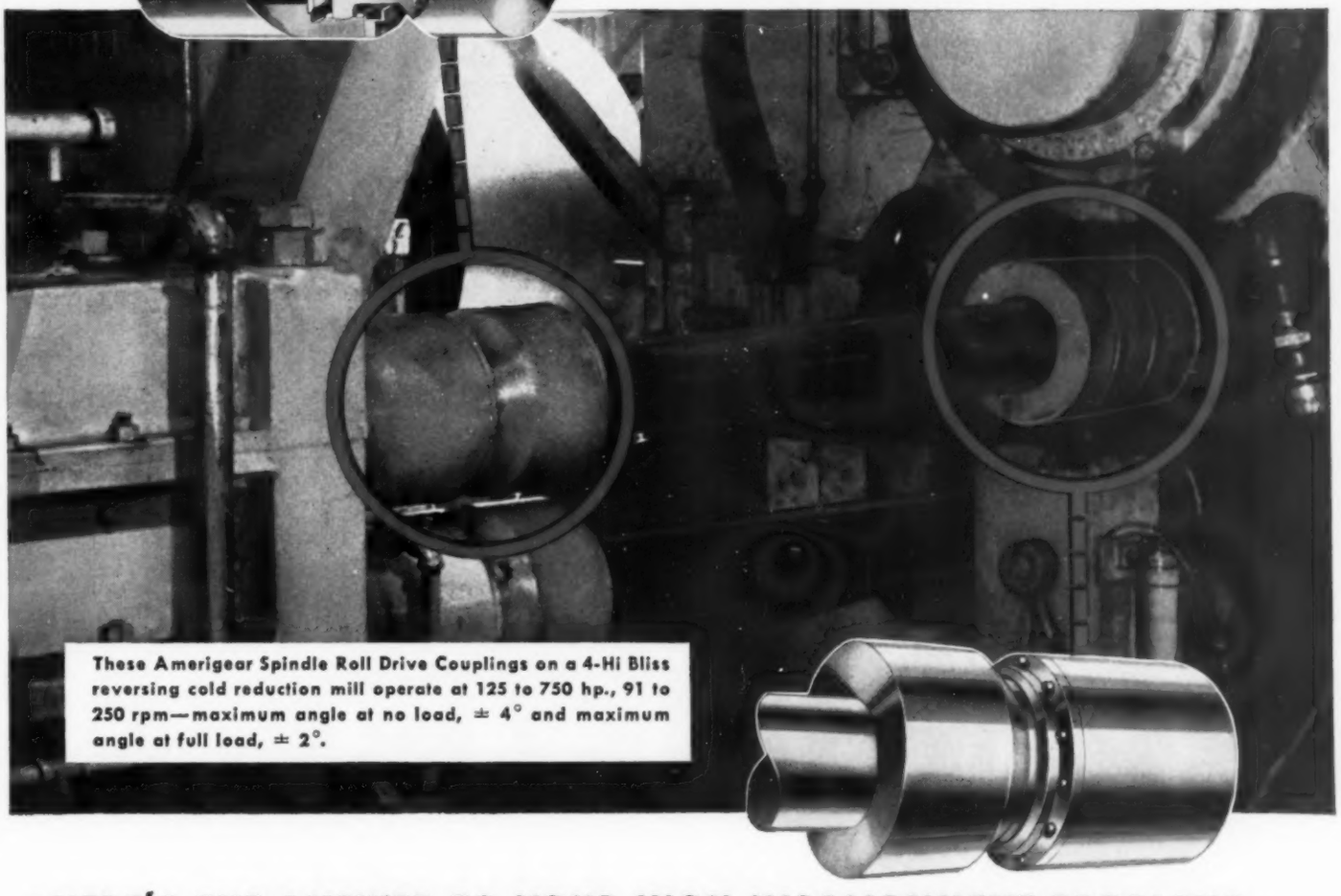
THE DE LAVAL SEPARATOR COMPANY Poughkeepsie, New York • 427 Randolph St., Chicago 6 • 2420 Grant Building, Pittsburgh, Pa.
DE LAVAL PACIFIC CO. 61 Beale St., San Francisco 5

TROUBLED WITH "SLIPPER-TYPE" COUPLING FAILURES?
CONVERT TO
Amerigear® SPINDLE ROLL DRIVE COUPLINGS



. . . RUN LONGER WITHOUT MAINTENANCE

. . . MAKE ROLL CHANGES FASTER



These Amerigear Spindle Roll Drive Couplings on a 4-Hi Bliss reversing cold reduction mill operate at 125 to 750 hp., 91 to 250 rpm—maximum angle at no load, ± 4° and maximum angle at full load, ± 2°.

• HERE'S THE ANSWER TO YOUR HIGH MISALIGNMENT PROBLEMS . . .

Amerigear's Fully-Crowned Tooth Form concentrates the load towards the center of the tooth, eliminates tooth end and tip loading. This permits an extremely high degree of angular and lateral misalignment—up to ± 9° per engagement—with no wear or loss of power.

And By Accomodating For Roll Wear and varying distances between roll centers, Amerigear Spindle Roll Drive Couplings keep your maintenance expenses to a minimum. That's because they're precision-manufactured to transmit power to the rolls smoothly and continuously . . . even after repeated roll grinding . . . *without maintenance.*

Downtime Goes Down, Too because engaging roll end teeth are specially designed for quick assembly and disassembly. So the next time you're in need of flexible couplings for your ferrous or non-ferrous rolling mills, convert to Amerigear — a highly engineered solution to your every high misalignment problem.

Amerigear Engineers are ready to help you design improved operating efficiency into heavy presses, slitters, cranes, reels or other steel mill equipment. Write for Catalog 501 and Bulletin 1052, or attach coupon below to your letterhead.

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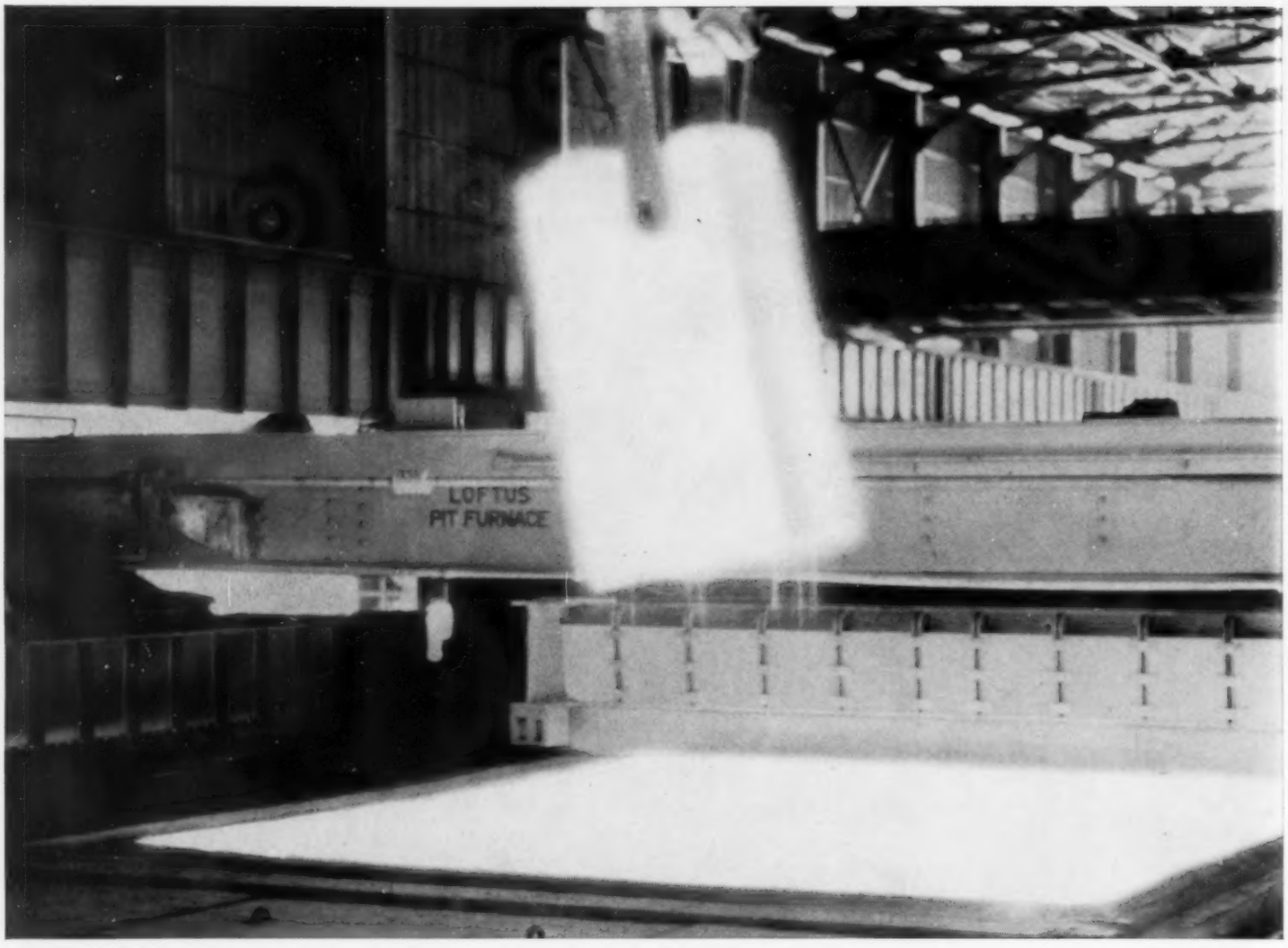


HAGAN CONTROL &

Provide Accurate Fuel-Air Ratio Control at U. S. Steel's CLAIRTON SOAKING PITS

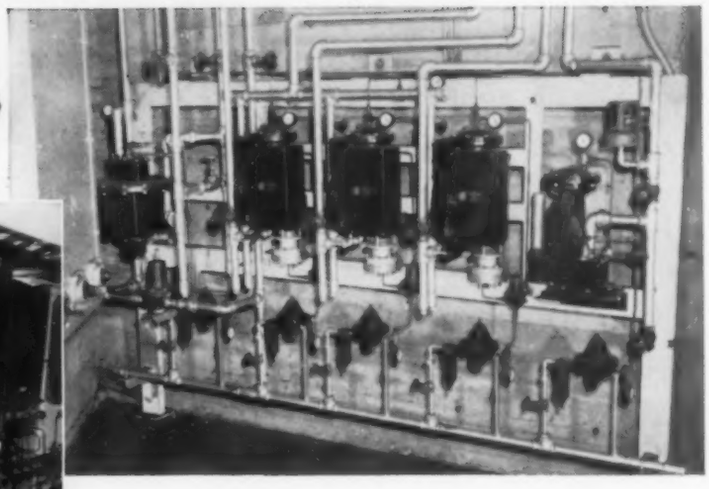
The newly rebuilt U. S. Steel Clairton soaking pits, designed by Loftus Engineering Corporation, are noteworthy for the comparatively short track time involved, the use of non-luminous flame (requiring higher air pressure), and the fact that they are used for treating a wide variety of steels.

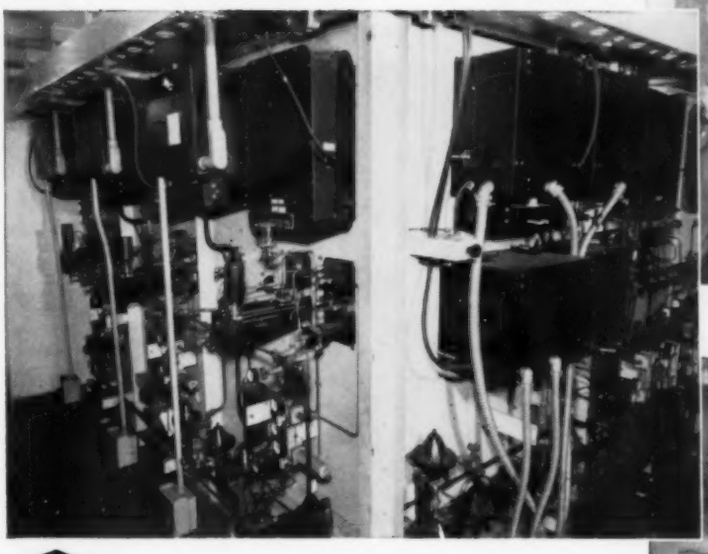
All of these factors demand accuracy and dependability in the control system. The Hagan systems now in use at Clairton provide more than the required precision, reliability and speed. Since the control lines are pneumatic, good housekeeping is easy, and safety is insured.

In addition to fuel-air ratio, the Clairton pits have Hagan control and metering of gas pressure, fan pressure, recuperator temperature and flue pressure. Hagan pneumatic systems are simple, direct-acting and are built to endure the most severe operating conditions.

Hagan's wide experience with automatic controls for soaking pits, blast furnaces, open hearths and heating furnaces is at your disposal. Call your nearest Hagan representative when you have a problem.

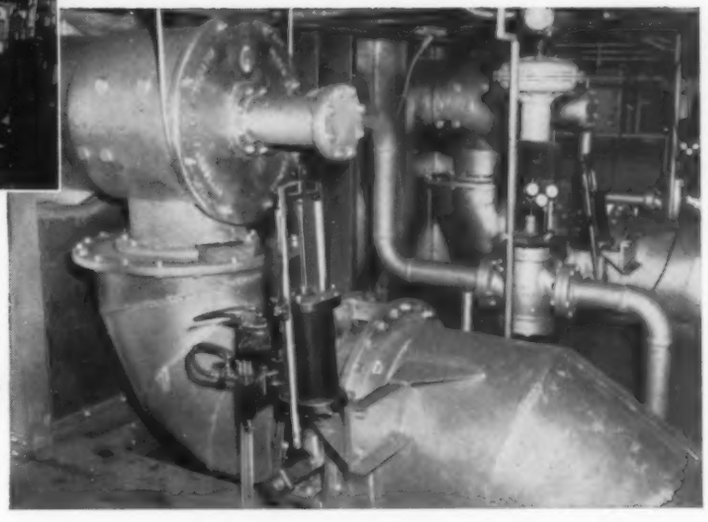
FLUE DRAFT, AIR FLOW AND COMBUSTION AIR TRANSMITTERS
Note simplicity of installation.





REAR OF CONTROL PANEL
Note accessibility.

PIT AIR DAMPER POWER UNIT
Precision positioning regulator—repeatability 0.5%.



INSTRUMENTATION

FUEL-AIR RATIO CONTROL regulates combustion air flow in proportion to gas flow to each pit. Automatic compensation is made for temperature variations of heated air. Gas and air flows are recorded, and gas flows integrated on Hagan Ring Balance Meters. Air-to-gas ratio is manually adjustable at the control panel.

PRESSURE CONTROLS consist of independent systems for the control of:

- Main line gas pressure for both rows of pits.
- Forced draft outlet pressure to each row.
- Pit pressure by positioning of stack dampers.

Interlocks cut off air and gas flow, and move stack damper to a pre-determined safe position when pit cover is lifted.

RECUPERATOR is protected against overheating at low flows by temperature control. Excess heated air is automatically bled off to atmosphere.

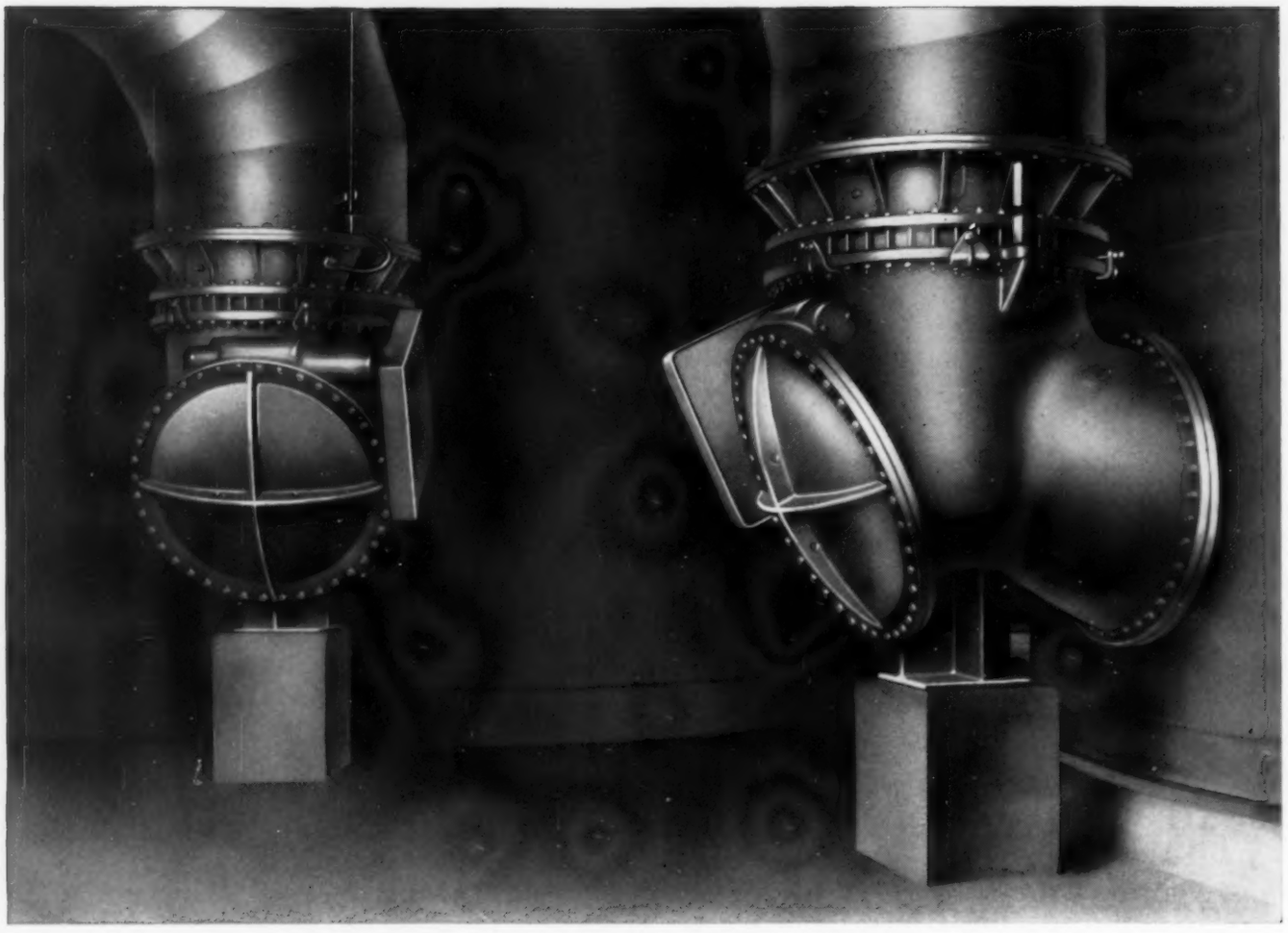
These Hagan Automatic Control Systems maintain operating conditions in the pits at high efficiency, so that production can be held to maximum levels with minimum scaling of ingots. Safety and cleanliness are assured with Hagan *pneumatic* controls.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

HAGAN BUILDING • PITTSBURGH 30, PENNSYLVANIA

Metallurgical Furnace Control Systems • Boiler Combustion Control Systems • Ring Balance Flow and Pressure Instruments • Control Systems for Aeronautical and Automotive Testing Facilities



622 Freyn-Design Chimney Valves in Service...

No Replacements!

The impressive service record of the Freyn-Design Chimney Valve for hot blast stoves is the best proof of its reliability.

It is a mushroom valve of the angle type, in which a simple, positive counterweight mechanism, passing over dead center, locks the disc in open or closed position. The valve disc opens away from the water-cooled seat and, when in the open position, is out of the path of the stream of hot stack gases.

When the spherically-machined disc is closed, stove blast pressure automatically forces a tight, sure closure. The valve can be cycled in less than 30 seconds, and may be operated manually either at the valve or from a floor stand on the floor above. It can also be provided with a motor or compressed air operator.

Freyn-Design Chimney Valves—in both top and bottom discharge design, with and without cold blast connections—have been proved in 622 installations. None has ever been replaced.

Investigate the long-range reliability and economy of Freyn-Design Chimney Valves for your hot blast stoves. We'll be glad to provide you with complete design and cost information. Write or call today!

KOPPERS COMPANY, INC.

KOPPERS

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Engineering & Construction Division

KOPPERS BUILDING • PITTSBURGH 19 *Associated with* Ashmore, Benson Pease & Co. Ltd., Stockton-on-Tees, ENGLAND; De Lattre & Frouard, Paris, FRANCE

with ASKANIA Edge Position Control

A Pittsburgh district steel mill slits this ¼" rough edge from 15-ton reels of blackplate at 3,000 feet per minute with accuracy of ± 1/64". They do this precision edge-positioning job with Askania Hydraulic Edge Position Control.

Askania Edge Position Control is a new use for the Askania Jet Pipe Regulator, long the educated muscle of the steel mill. Steel men asked for it, because they needed the dependability and simplicity of Askania in this control job.

Nothing touches the steel but a stream of low pressure air. Available force is practically unlimited. The equipment is low in cost. There is nothing delicate about it. It's built to take all the abuse that continuous operation in hard service can give it.

Find out now about Askania Edge Position Control. See your Askania Representative, or write for Bulletin 161.

ASKANIA REGULATOR COMPANY
246 E. Ontario Street, Chicago 11, Illinois
A Subsidiary of General Precision Equipment Corporation

Straightens tubes of standard wall thicknesses, in all grades, from 4½" to 16½"

...40 TIMKEN® bearings carry the load!

WHEN the Sutton Engineering Company built their new No. 5 M KTC tube straightener, they knew it had to give many years of rugged service despite heavy loads and constant use. So they mounted the two driven rolls, five idler rolls, speed reducer and table rolls on Timken® tapered roller bearings.

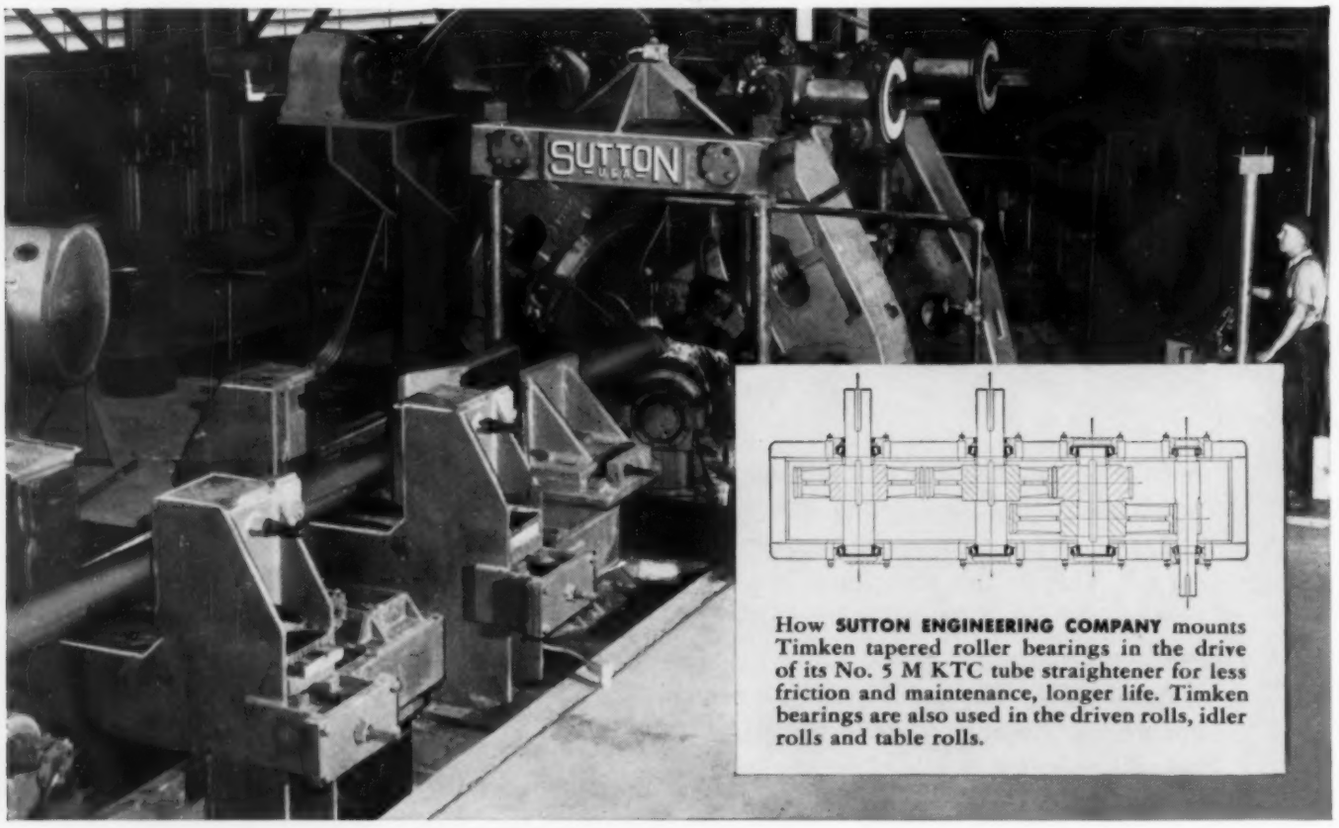
Timken bearings on the rolls easily handle the heavy radial and thrust loads as tubes up to 16½" pass through. That's because Timken bearings are tapered—take radial and thrust loads in any combination. No thrust bearings are required. And full line contact between rollers and races gives them extra load-carrying capacity. Timken bearings keep shafts in accurate alignment, assure smooth operation.

The compactness of Timken bearings permits a high load-carrying capacity in a relatively small-size bearing. Valuable space is saved.

Wear is held to a minimum because Timken bearings practically eliminate friction. They're designed by geometrical law to have true rolling motion. They're made with microscopic accuracy to conform to their design. And they're made of nickel-rich steel we make ourselves. We're the only bearing maker in the country who takes this extra step to insure quality.

To get all these advantages, always specify Timken bearings in the equipment you build or buy. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **SUTTON ENGINEERING COMPANY** mounts Timken tapered roller bearings in the drive of its No. 5 M KTC tube straightener for less friction and maintenance, longer life. Timken bearings are also used in the driven rolls, idler rolls and table rolls.

IT'S TIMKEN BEARINGS FOR VALUE!

To get the best value in bearings you may find this simple formula helpful:

$$Value = \frac{quality + service + public\ acceptance}{price}$$

Obviously a big advantage *above* the line gives you more value than a small one *below*. No other bearing can match the uniform high quality, engineering and field service and overwhelming public acceptance you get with Timken bearings.

TIMKEN

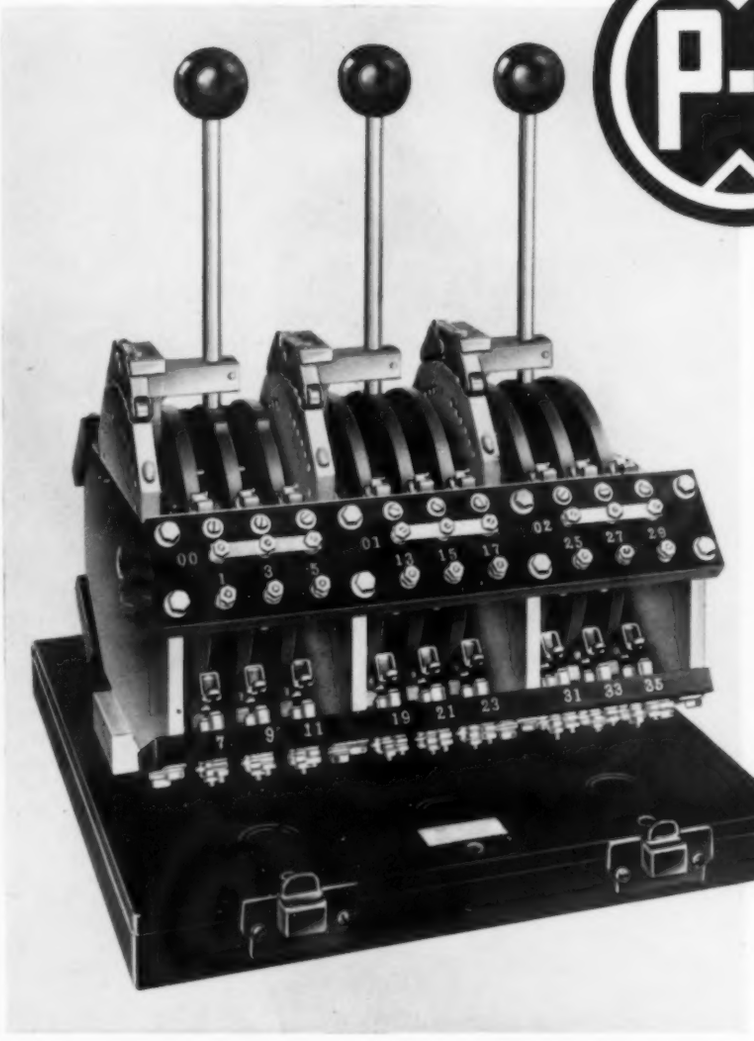
TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION →◎←

Type MD

FOR GENERAL APPLICATION
IN MILL SERVICE



P-G master switches

Unique in design, the Post-Glover Type MD Master Switch saves valuable mounting space in crowded crane cabs or mill pulpits where sufficient room has always been a problem. Up to four single masters can now be furnished in one enclosure on a single base, thereby simplifying installation of the switch.

Each single master has a maximum of 12 circuits and up to 6 points either direction. The operating lever has exceptionally short angular travel and can easily be adjusted in length, thus adding to operator comfort and efficiency.

Write for Bulletin 410

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

"Forgings stay straight as an arrow in these furnaces"

says
Clair J. Koehler,
U. S. Steel Heater

Our Homestead Forgings Division has the most modern heat treating facilities available to accommodate the most critical forging specifications.

These vertical furnaces, for example.

These furnaces permit the ultimate in temperature control and completely eliminate any possibility of distortion even when heating forgings, such as the turbine rotor shown, to temperatures as high as 1830°F!

Why did we install these furnaces?

Clair Koehler, a heater for 15 of his 31 years with us, can answer. "Large shafts stay straight as an arrow in these verticals. We get better temperature control, too. Total temperature variation is less than 10°F. from top to bottom."

Such laboratory-type precautions are typical of the care all forgings receive at United States Steel.

Address inquiries or requests for our free 32-page booklet on USS Quality Forgings to United States Steel, Room 4727, 525 William Penn Place, Pittsburgh 30, Pa.

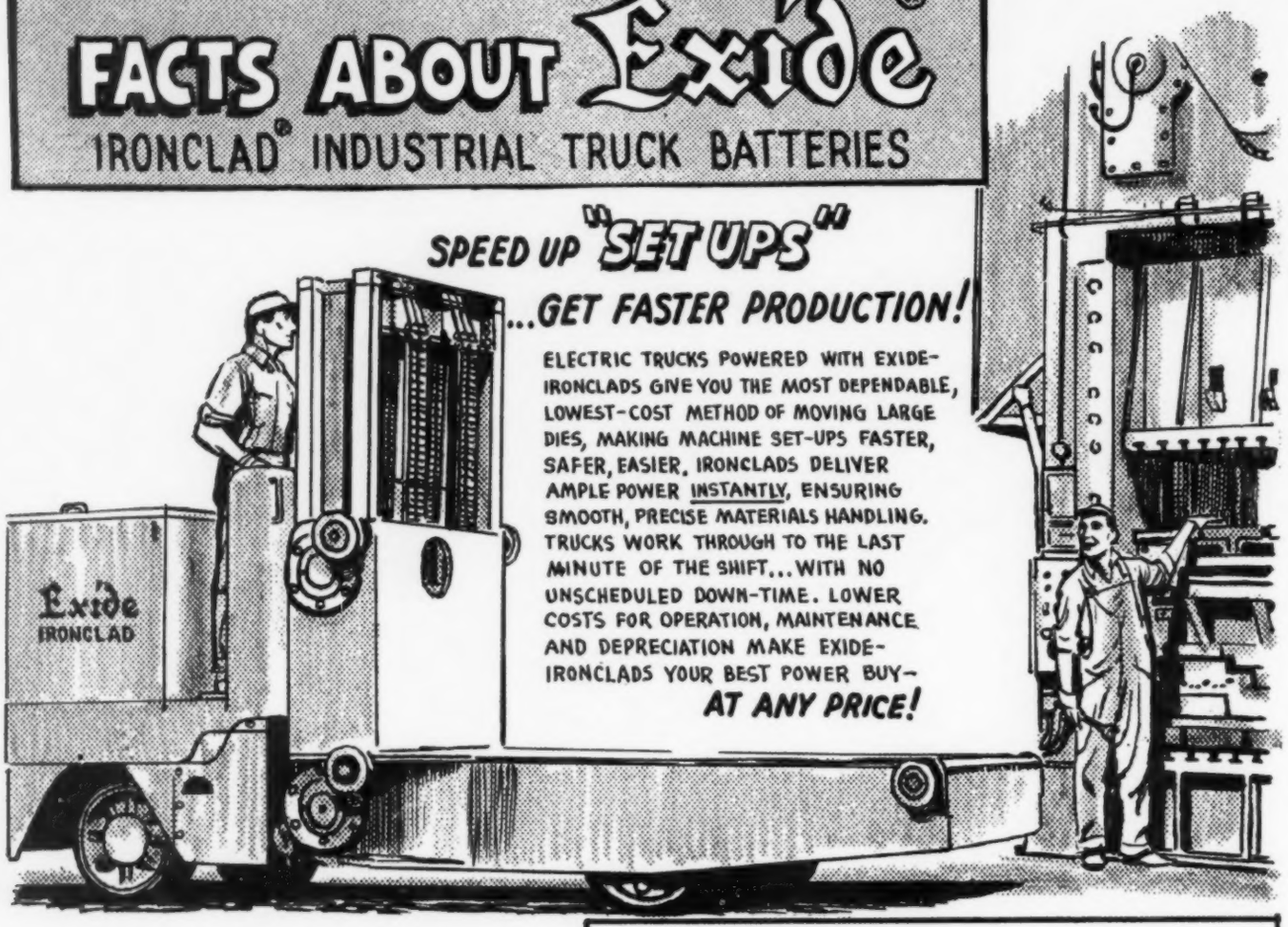
UNITED STATES STEEL

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

USS Quality FORGINGS

- heavy machinery parts—carbon, alloy, stainless
- forged steel rolls and back-up roll sleeves
- electrical and water wheel shafts
- hammer bases and columns

FACTS ABOUT Exide®
IRONCLAD® INDUSTRIAL TRUCK BATTERIES



SPEED UP "SET UPS" ...GET FASTER PRODUCTION!

ELECTRIC TRUCKS POWERED WITH EXIDE-IRONCLADS GIVE YOU THE MOST DEPENDABLE, LOWEST-COST METHOD OF MOVING LARGE DIES, MAKING MACHINE SET-UPS FASTER, SAFER, EASIER. IRONCLADS DELIVER AMPLE POWER INSTANTLY, ENSURING SMOOTH, PRECISE MATERIALS HANDLING. TRUCKS WORK THROUGH TO THE LAST MINUTE OF THE SHIFT... WITH NO UNSCHEDULED DOWN-TIME. LOWER COSTS FOR OPERATION, MAINTENANCE AND DEPRECIATION MAKE EXIDE-IRONCLADS YOUR BEST POWER BUY— *AT ANY PRICE!*

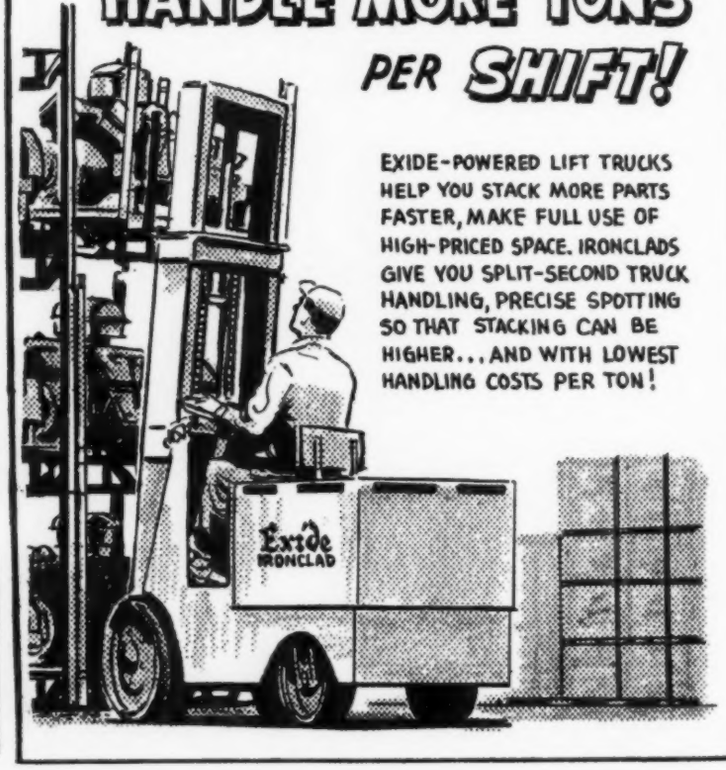
TUBES OF POWER

INSIDE EVERY IRONCLAD ARE SLOTTED TUBES THAT KEEP THE ACTIVE MATERIAL IN FIRM CONTACT WITH CONDUCTING GRIDS OF THE POSITIVE PLATES. THE ELECTROLYTE FLOWS EASILY THROUGH THESE NON-CORRODING SLOTS TO REACH MORE ACTIVE MATERIAL FASTER. RESULT: AN IRONCLAD DELIVERS GREATER POWER... FOR A LONGER TIME... AT LOWEST COST!

® PROTECTED SILVIUM CONDUCTING GRID
COMPRESSED ACTIVE MATERIAL
SLOTTED POLYETHYLENE RETAINER TUBE

LET EXIDE HELP SOLVE YOUR INDUSTRIAL TRUCK BATTERY PROBLEMS. ❶ CALL AN EXIDE SALES ENGINEER FOR FULL DETAILS. ❷ WRITE FOR FORM 1982, A MANUAL ON INSTALLING AND MAINTAINING MOTIVE POWER BATTERIES.

HANDLE MORE TONS PER SHIFT!



EXIDE-POWERED LIFT TRUCKS HELP YOU STACK MORE PARTS FASTER, MAKE FULL USE OF HIGH-PRICED SPACE. IRONCLADS GIVE YOU SPLIT-SECOND TRUCK HANDLING, PRECISE SPOTTING SO THAT STACKING CAN BE HIGHER... AND WITH LOWEST HANDLING COSTS PER TON!

Exide INDUSTRIAL DIVISION, The Electric Storage Battery Company, Philadelphia 2, Pa.

Actually see Rust-Oleum applied directly over sound rusted surfaces in your own plant.

Get proof of performance right in your own plant! See Rust-Oleum 769 Damp-Proof Red Primer applied over *your own* rusted metal after simple scraping and wire-brushing to remove rust scale and loose rust. Rust-Oleum's *specially-processed* fish oil vehicle penetrates rust to bare metal—saving time, labor and money.

Rust-Oleum finish coatings in Aluminum, Gray, White, Black, Orange, Blue, Yellow, Green and others provide both *Rust Prevention and Decorative Beauty!* Specify Rust-Oleum for new construction, maintenance and re-modeling. See Sweet's for catalog and nearest Rust-Oleum Industrial Distributor, or clip coupon to your letterhead . . .

There Is Only One Rust-Oleum. It is as Distinctive as Your Own Fingerprint.

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See local classified telephone directory under Rust Preventives or Paints for nearest Rust-Oleum Industrial Distributor.

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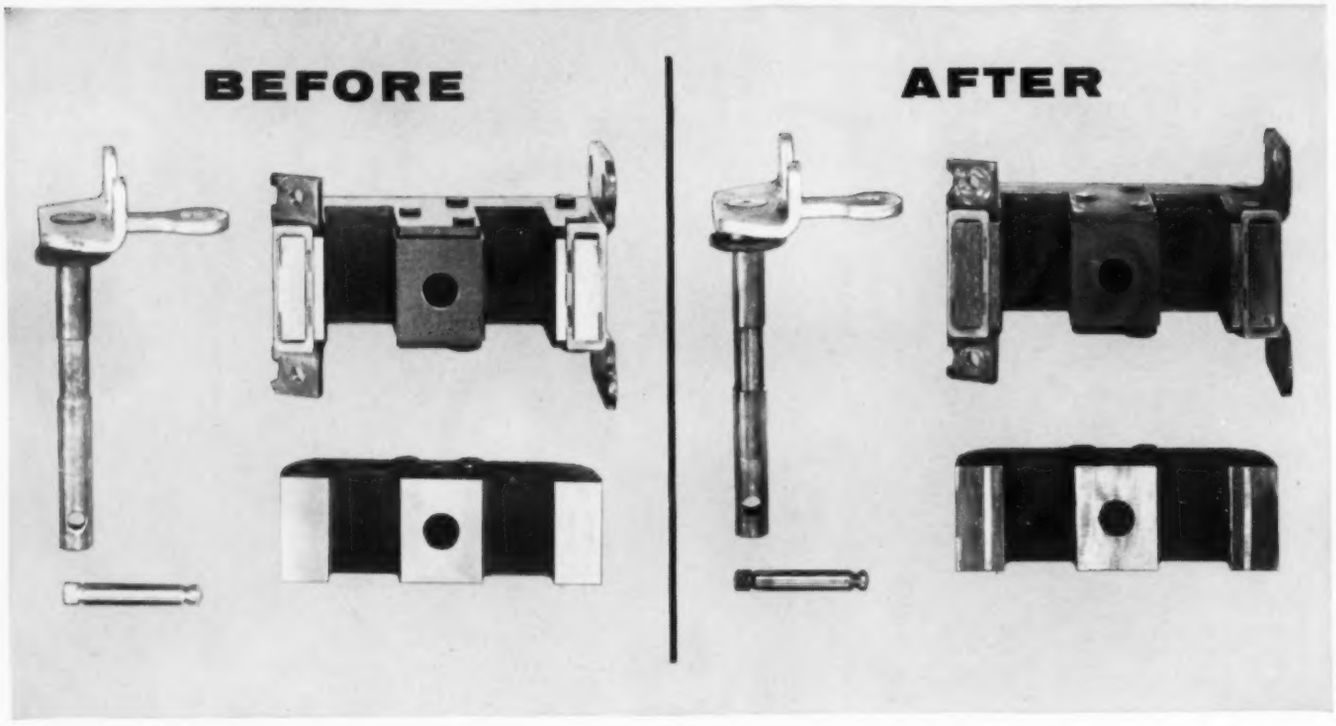
- ☐ Test Application of Rust-Oleum Over Rusted Metal Surfaces in My Plant.
- ☐ Complete Literature with Color Chart.
- ☐ Nearest Rust-Oleum Industrial Distributor.



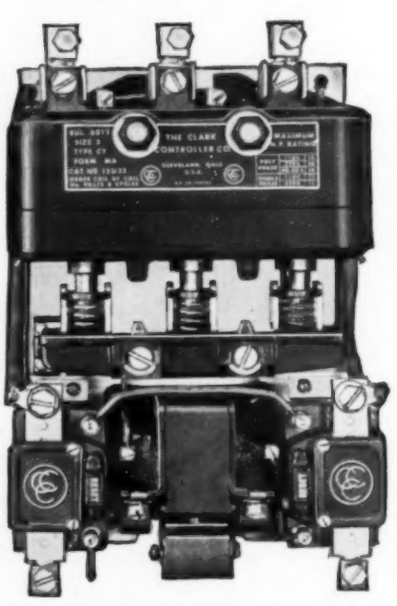
PROOF OF LONG LIFE OF CLARK TYPE "CY" STARTERS

These unretouched photos show magnet parts of a CLARK Bulletin 7707 Contactor—the contactor used on standard CLARK Bulletin 6013, Size 2, Type "CY" AC motor starters—as they looked before and after nearly 3 years of continuous service. During this time the contactor opened and closed 4 to 5 times per minute, 24 hours per day, 7 days per week—a total well over 5 million operations.

The contactor was in service at Taylor Instrument Companies, Rochester, N. Y., on a "Hevi-duty" molten salt pot electric furnace used for instrument calibration. It was installed *after several contactors of another make had failed in 4 months or less.* Our contactor was still performing perfectly when it was replaced by another identical unit, so that we could study the magnet wear.

All wearing surfaces were carefully "miked" and each dimension compared with the original. As seen in the "before and after" photos, wear was barely apparent to the naked eye. Micrometer readings showed actual wear measurable only in thousandths and ten thousandths of an inch. Only a fraction of the usable life had been consumed.

Write for descriptive literature.



CLARK Type "CY" Starters *include many more features for dependable service and reduced maintenance. Let us tell you the complete story.*

The **CLARK** **CONTROLLER** *Company*

Engineered Electrical Control

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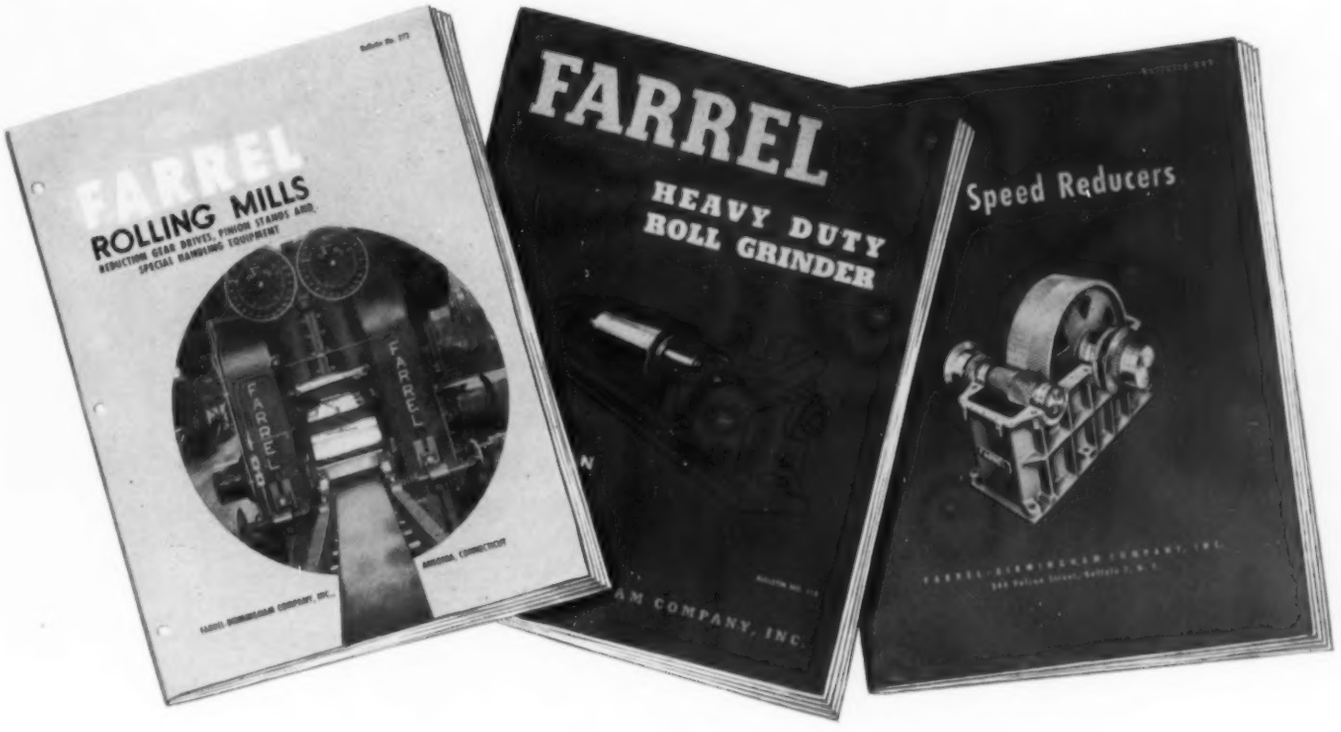

to rolling mill production problems

Bulletin No. 273 describes Farrel rolling mills, designed and built to individual requirements, in a wide range of types and sizes for rolling nonferrous rods, strips or sheets, metal foils and cold strip steel. It also tells about reduction gear drives and pinion stands, coilers and special handling equipment required to make each installation a complete unit.

Bulletin No. 115 shows in text, photographs and diagrams how the outstanding performance of the Farrel HD roll grinder is achieved. Features described in detail include automatic crowning and concaving device . . . smooth headstock drive by adjustable speed motor . . . vibration-free carriage traverse . . . centralized control of entire grinding operation.

Simple directions for selecting speed reducers of the horsepower and speed you need for auxiliary drives can be found in bulletin No. 449. It also contains specifications, horsepower rating tables, overhung load capacities, dimensions and weights of single and double reduction units.

For a free copy of any of these informative bulletins simply fill in the coupon below.

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- ☐ Bulletin No. 273, "Farrel Rolling Mills".
- ☐ Bulletin No. 115, "Farrel Heavy Duty Roll Grinder".
- ☐ Bulletin No. 449, "Farrel Speed Reducers".

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Specify J-M Superex, industry's favorite block insulation

Made from diatomaceous silica and asbestos for all temperatures to 1900F

YOU'LL ENJOY *greater insulation savings* with Superex®. Its unique combination of low conductivity and outstanding resistance to high temperatures provides greater operating efficiency and longer maintenance-free service. That's why Superex is the leading block insulation for furnace work.

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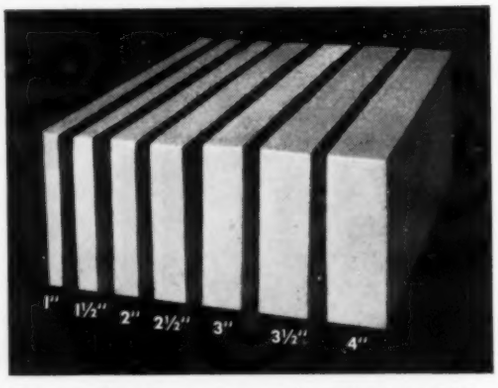
For high temperature equipment. Since its introduction in 1927, Superex has received enthusiastic acceptance. Today it economically insulates 90% of the country's hot blast stoves. Other high temperature equipment where Superex has proved its superior performance include most types of industrial and metallurgical furnaces and ovens, stationary and marine boilers, regenerators, kilns, roasters, high-temperature mains, flues and stacks.



Saves waste—Superex comes in 7 standard thicknesses from 1" to 4". Other sizes available on order.

For further information on Superex, write to Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ont.

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You can pull these plugs at full load . . . SAFELY!

Circuit-Breaking Arktite

PLUGS AND RECEPTACLES

20 amp. to 400 amp.—250V D.C.; 600V A.C.

SAFE at all times—even if you pull an *Arktite* plug to disconnect an energized motor or appliance in an emergency!

You don't have to open the disconnect switch before withdrawing an *Arktite*. Arcs created as line and load poles disengage are confined in deep, insulated arcing chambers—are instantly snuffed out by pressure-deionization and lack of oxygen. There's no possible danger of flashover injuring personnel or destroying property.

Contact your Crouse-Hinds Distributor, nearest Crouse-Hinds Office or Representative for complete information.

NEW, Re-Designed *Arktite*...

Features new pressure connectors — new easier-to-wire 1-piece interior assemblies — new easier-to-interchange plug and receptacle interiors — new plug adaptability to any type and size cable.

Fully interchangeable with older style. Same price. Currently available only in 30 amp. size, in 2-, 3- and 4-poles.

Operated like a giant switchboard, this *Arktite* installation with variations in power, frequencies and voltages is used to speed up machine tool testing. Plugs can be inserted and withdrawn from "live" receptacles without using a disconnect switch.

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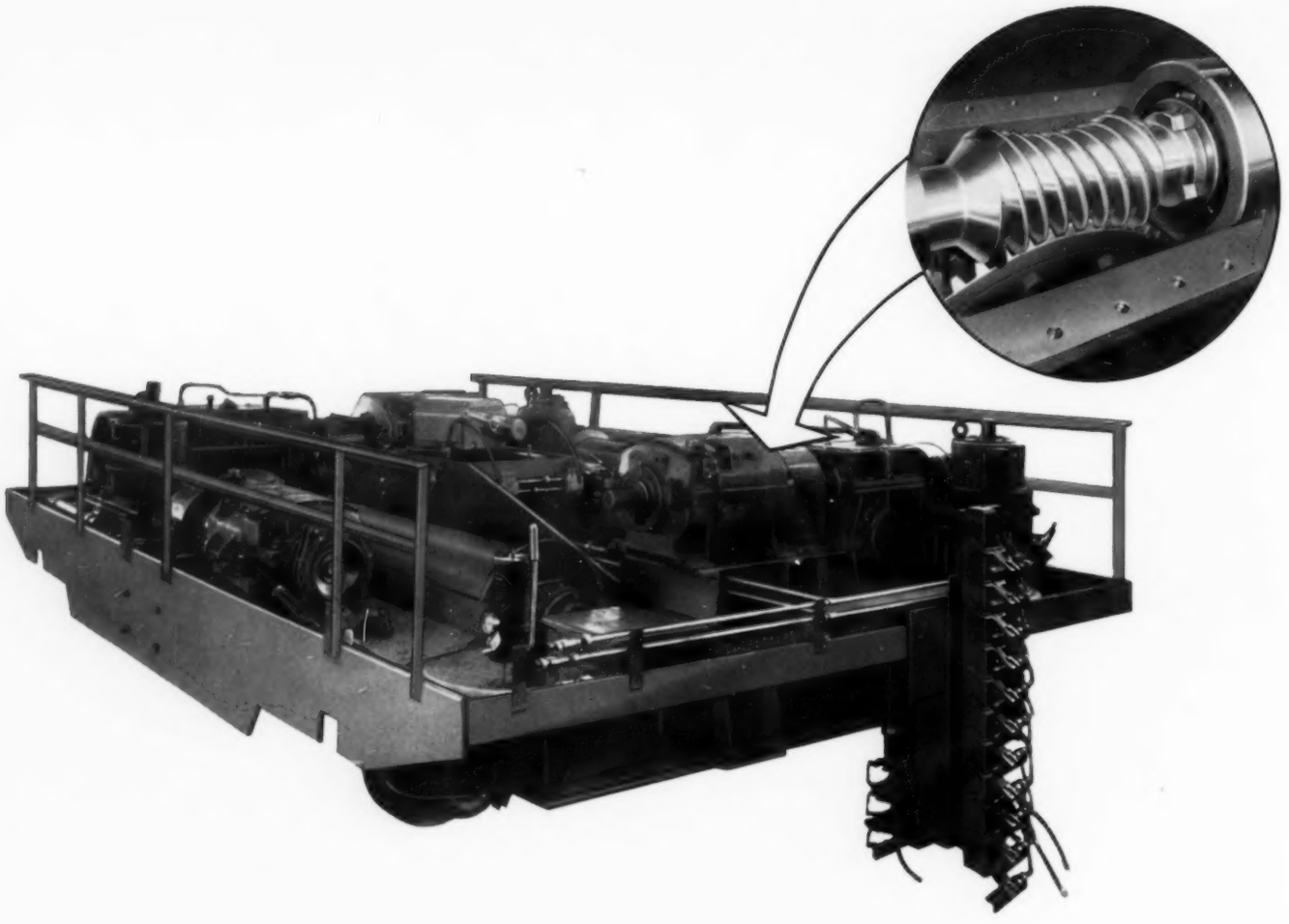

WORM GEARED TROLLEYS TO A.I.S.E. SPEC'S... *by "Shaw-Box"*

For those who prefer worm gearing, this 30-ton trolley with 5-ton auxiliary hoist — both worm geared and built to A.I.S.E. specifications — is a typical example of how "Shaw-Box" interprets these specifications.

Whichever you prefer — spur or worm gearing — you will do better with "Shaw-Box" trolleys. We've built many cranes, ranging from 5 to 200 tons capacity, to A.I.S.E. specifications No. 6. In all "Shaw-Box" Cranes — whether built to an individual mill's or A.I.S.E. specifications — you get the added advantages that come from more than 65 years of building overhead load-handling equipment exclusively; as well as from "Shaw-Box" engineering, fine workmanship, and precision manufacturing methods.

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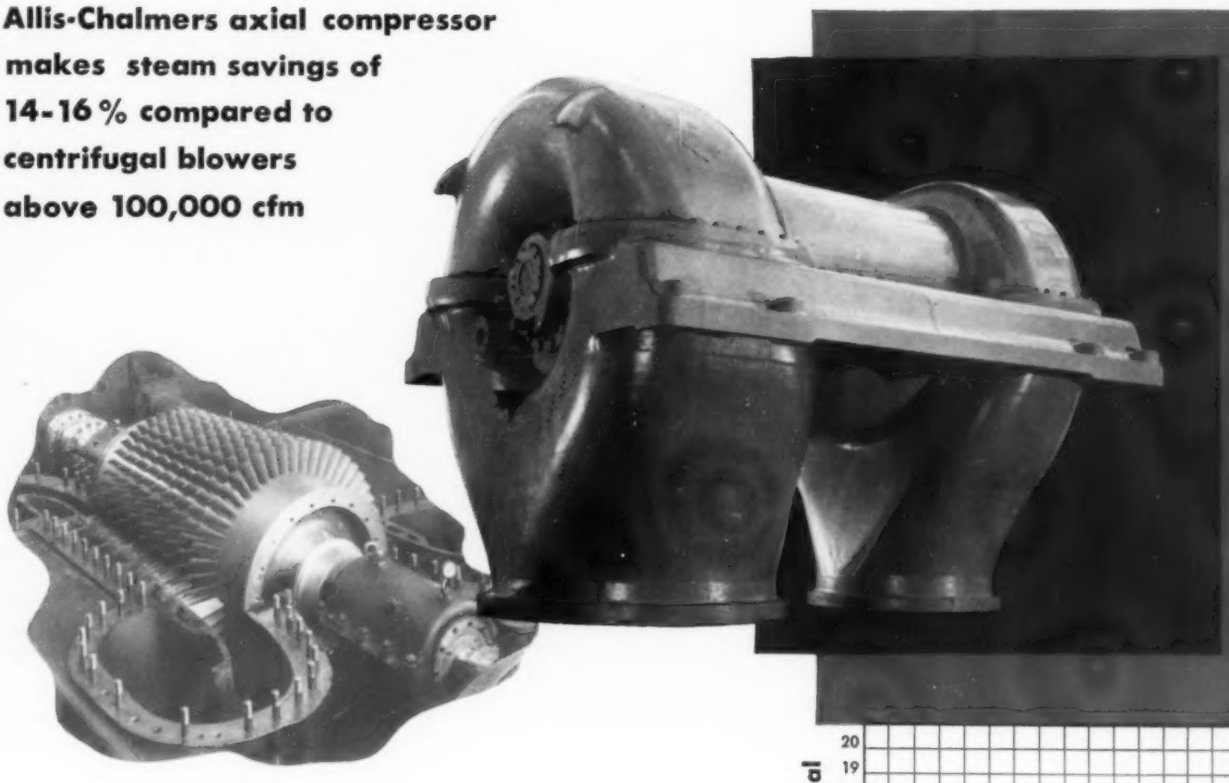
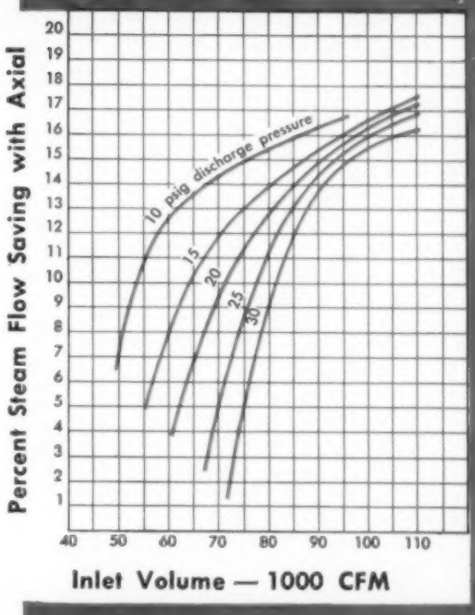
Blast Furnace Operators Can

Save to $50,000 a Year on Steam

Allis-Chalmers axial compressor makes steam savings of 14-16% compared to centrifugal blowers above 100,000 cfm





Three factors combine to provide outstanding savings:

1. Higher efficiency of axial compressor. This advantage is inherent. Air path in axial is nearly a straight line. Losses due to sharp turns (as in multi-stage centrifugal blowers) are eliminated.

2. Higher turbine efficiency. At 100,000 cfm and above, the speed of an Allis-Chalmers axial compressor approaches the optimum speed of 3600 rpm. In contrast, the speed of a centrifugal blower drops to 2600 or 2700 rpm. This higher design speed results in higher turbine efficiency — added steam flow economy for the axial compressor.

3. Steam condenser required is smaller.

Axial compressors are also smaller, easier to install. They require less floor space, smaller foundations than centrifugal blowers of the same rating.

Unbiased Recommendations

Allis-Chalmers builds both axial and centrifugal types. Whatever your blower problem, call your nearby A-C office, or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4731

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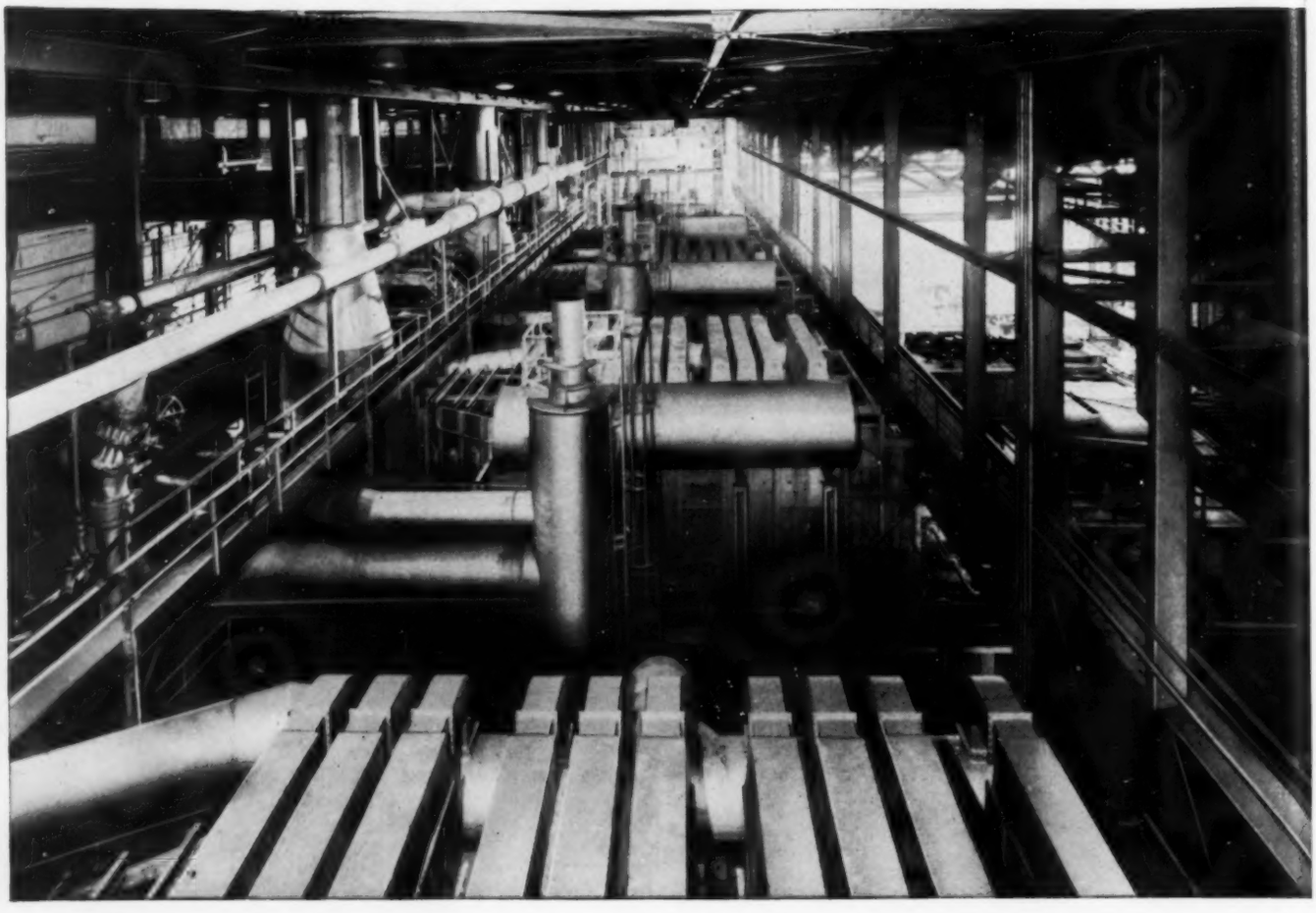
HAZEN METALLIC RECUPERATORS



Hazen Metallic Recuperators installed above 4 new Slab Reheating Furnaces at Fairless Works, United States Steel

the only 100% American Metallic Recuperator

- Entirely made in U.S.A. All inner and outer tubes made of Stainless Steel.
- This application takes advantage of the natural upward flow of flue gases.
- Less stack draft is required.
- Increased preheat . . . due to availability of a larger percentage of flue gases at higher temperatures.

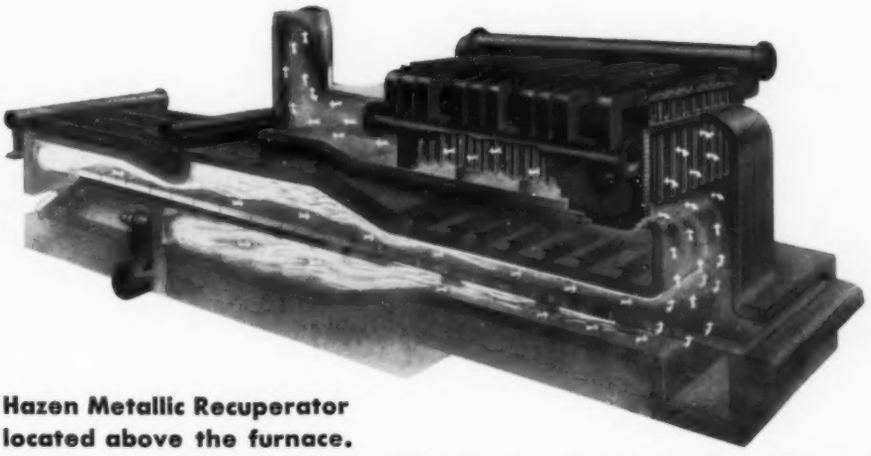
Consult us about improving the production and economy of your furnace operations

improve FURNACE production and economy

by taking advantage of

What Comes Naturally

in the flow of flue gases from the furnace to the recuperator



Hazen Metallic Recuperator located above the furnace. Greater furnace economy is derived when space permits this position.

CONVENTIONAL APPLICATIONS
RESIST
THE NATURAL UPWARD FLOW OF GASES

IMPROVED APPLICATIONS
ASSIST
THE NATURAL UPWARD FLOW OF GASES

- **Economies in initial cost . . . by reducing the required amount of excavating and furnace foundation . . . by reducing the length of flue ordinarily required from furnace to stack.**
- **Recuperator, flue and stack may be supported from steel work independent of the furnace bindings.**
- **Walkways may be provided around the recuperator for convenience of inspection and cleaning.**
- **Recuperator may be applied above an existing furnace with a minimum loss in outage time.**

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Crops *and* Shorts

THE following foreword, from a booklet "The Story of Creative Capital," published by E. I. Du Pont de Nemours & Company, has a lot of meat:

Once there was a man named Karl Marx, a brooding man whose sleep was troubled, a man who looked darkly at the world about him. He was a thoughtful man and, as he viewed the rise of mill and factory, he devised a theory. His theory was simple: Ownership of the mills, as with ownership of the land, was the key to the future. Ownership should, therefore, be vested not in the hands of the few, but with something he identified as The People.

A hundred years later, in the United States of America, something that Marx hadn't figured was going on. Ownership by the people? Yes indeed: by the thousands, by the millions of people. Millions owned the homes they lived in, millions the land they tilled. Millions owned a share of the possession Marx valued highest, the tools of production. Young people, old people, rich people, poor people. An up-and-coming couple in Manhattan. A quiet widow in Virginia, tending by her dooryard the roses she had planted so long ago. A giant steel puddler in Gary, proud of his strength and his skill. A gentle nun in Nebraska, a trustee for a hundred orphaned juniors, owners themselves tomorrow. A lobsterman in Maine, a steamboat mate in Louisiana, an oil driller in Texas. People in droves, people in throngs, people in hordes, people in multitudes. The people. The people of the United States.

Yes, the people own the tools of production. By his own definition, Karl Marx' prophecy has been realized. How odd a quirk of fate that in Russia, where he is revered, his dreams should have been shredded on the jagged shards of "state" bureaucracy. How odd to find that it is here, in the capitalism he reviled, that the promise of the tools has been fulfilled.

▲

THE selection of B. F. Fairless as president of The American Iron and Steel Institute has been universally acclaimed a wise choice. Mr. Fairless has the respect of industry, of government and of labor, and has experience and ability in acting as spokesman for the iron and steel industry. We think the move a perfect one, fulfilling as it does our two-year-old prediction.

▲

SPEAKING before The American Iron and Steel Institute, Arthur B. Homer, president of Bethlehem Steel Co., said that, in the next 15 years, population of the United States is expected to reach 200,000,000, and the gross national product to hit $570,000,000,000 per year. This would require an annual ingot capacity of 185,000,000 tons, which would mean a 50 per cent increase for the entire industry and call for about 4,000,000 tons of additional capacity each year.

This expansion, plus the replacement of obsolete facilities, points to good long range business in this field.

▲

THE American Iron and Steel Institute awarded Gary medals to T. M. Girdler of Republic Steel Corp., C. R. Hook of Armco Steel Corp., and E. T. Weir of National Steel Corp.

The American Iron and Steel Institute Medal was awarded to A. P. Woods, Jr., research engineer with Armco Steel Corp., for his paper: "Some Statistical Methods Used in Studies of Steel Plant Operations."

Dr. E. F. Osborn, of Pennsylvania State University, received the regional technical meeting award for his paper: "Phase Equilibrium Studies of Steel Plant Refractories Systems."

▲

HAVE you ever stopped to think that the generation which now worries about the younger generation is the generation that was worried about a generation ago?

▲

STEEL production in the United States in May hit an all-time monthly record — more than 10,300,000 tons.

And for the third consecutive month, Inland Steel Co. set a new production record with an output of 462,032 net tons of ingots. The plant's blast furnaces also established a new record with a production of 265,793 tons of pig iron.

▲

FORESEEING a possible lack of management personnel as a limitation of future growth of the company, General Electric is running a school of business administration for its executives. About 300 individuals attend each year.

▲

ALTHOUGH the United States can well feel proud of its great steel-producing capacity, we should not overlook the fact that, of twenty alloying elements used in steelmaking, we are totally lacking in eight and deficient in the other twelve.

▲

AS bargaining talks progress between the United Steel Workers and the steel companies, it is interesting to reflect that the present employment cost in the industry averages $2.586 per hour, including the cost of pensions, social security and insurance. This doubles the rate of just ten years ago. The present negotiations will result in a raise of 12-15 cents an hour . . . and next year and the year after will see further raises . . . with consequent increases in the price of iron and steel products.

As one banker put it: "What we are doing is wrong, we know it is wrong, but it seems to work."

Actually, it seems to work only because, through gradual inflation, we are spending the money that all of us have put into insurance, savings, annuities, etc., as protection for old age or loss of earning power.

While we dance, let's hope the piper's bill won't be too high.

Practical service training at Honeywell's school . . .

makes your instrument men more valuable

Your instrument maintenance men can get a real education in the most up-to-date methods for servicing instruments, at Honeywell's Training School. Any organization which uses Honeywell instruments can send maintenance personnel to this school. Tuition costs you nothing, for this school is maintained as a "plus-value" service to Honeywell customers.

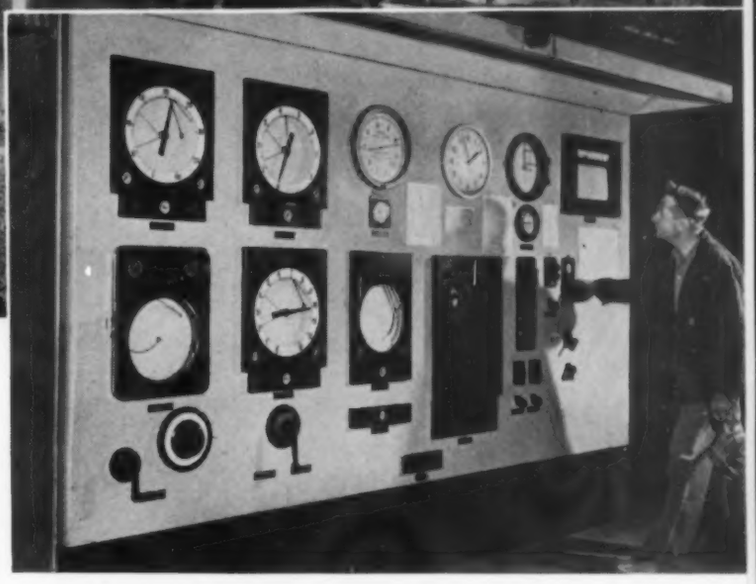
Thousands of technicians have either started or augmented their instrument knowledge here. A variety of courses is available, to fit men for the particular kind of maintenance problems they may encounter in their specific jobs. The comprehensive course . . . one of the most complete and intensive offered anywhere . . . covers about thirteen weeks. Other courses cover five weeks and less, to offer condensed instruction of either a basic or "refresher" nature to men who can't be spared for extended periods.

There's nothing academic about this school. The emphasis is placed on practical knowledge. Theory through lectures and textbook study is liberally supplemented by laboratory sessions and actual bench work on all types of instruments and related equipment.

One caution: classes have to be limited to assure thorough attention to all students, so make reservations in advance. Your local Honeywell office will be glad to make arrangements. Call today . . . it's as near as your phone.

Ford open hearths instrumented for top efficiency

Listed in Catalog 1531 are the varied types of ***ElectroniK*** *Controllers . . . including electric and pneumatic systems affording a broad selection of control action. Write for your copy.*



Big production at economical cost comes from this open hearth furnace at Ford Motor Company's Rouge Plant. Combustion and reversal are controlled by Brown instruments on this panel.

with flexible *ElectroniK* control

AS PART of a thorough modernization program of steel producing facilities, Ford Motor Company has equipped the open hearth furnaces at the Rouge plant with up-to-date Brown instrumentation. By controlling vital variables with exceptional accuracy and dependability, this integrated system proves valuable in gaining top production at economical Btu rate per ton.

High combustion efficiency results from accurate proportioning of fuel, steam and air fed to the burners. Sensitive *ElectroniK* flow meters measure the flow of oil, coke oven gas and steam. Through interlocked control, they regulate flow of combustion air in proportion to total fuel, and steam flow in proportion to oil. A total Btu control system, using a *Tel-O-Set* indicator and controller, regulates fuel input to use all available gas . . . to maintain maximum economy.

Efficient reversals. *Radiamatic* elements, with an *ElectroniK* controller, measure checker temperatures. This instrument works with a Bloom pneumatic reversal unit. The overall speed and sensitivity of the system provides fast reversals and uniform checker temperatures.

Simplified maintenance. Manual by-pass panels on all controllers permit servicing or removal of the instruments without interrupting manual operation of the furnace.

Available from Honeywell is a complete line of instrumentation for controlling critical temperatures, flows and pressures in open hearth and other metallurgical furnaces. An experienced application engineering staff combines these components into integrated systems, custom-made for the individual furnace. For a discussion of your particular requirements, call your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA: Write for Catalog 1531, "*ElectroniK* Controllers," and for Data Sheets on specific furnace control applications.**

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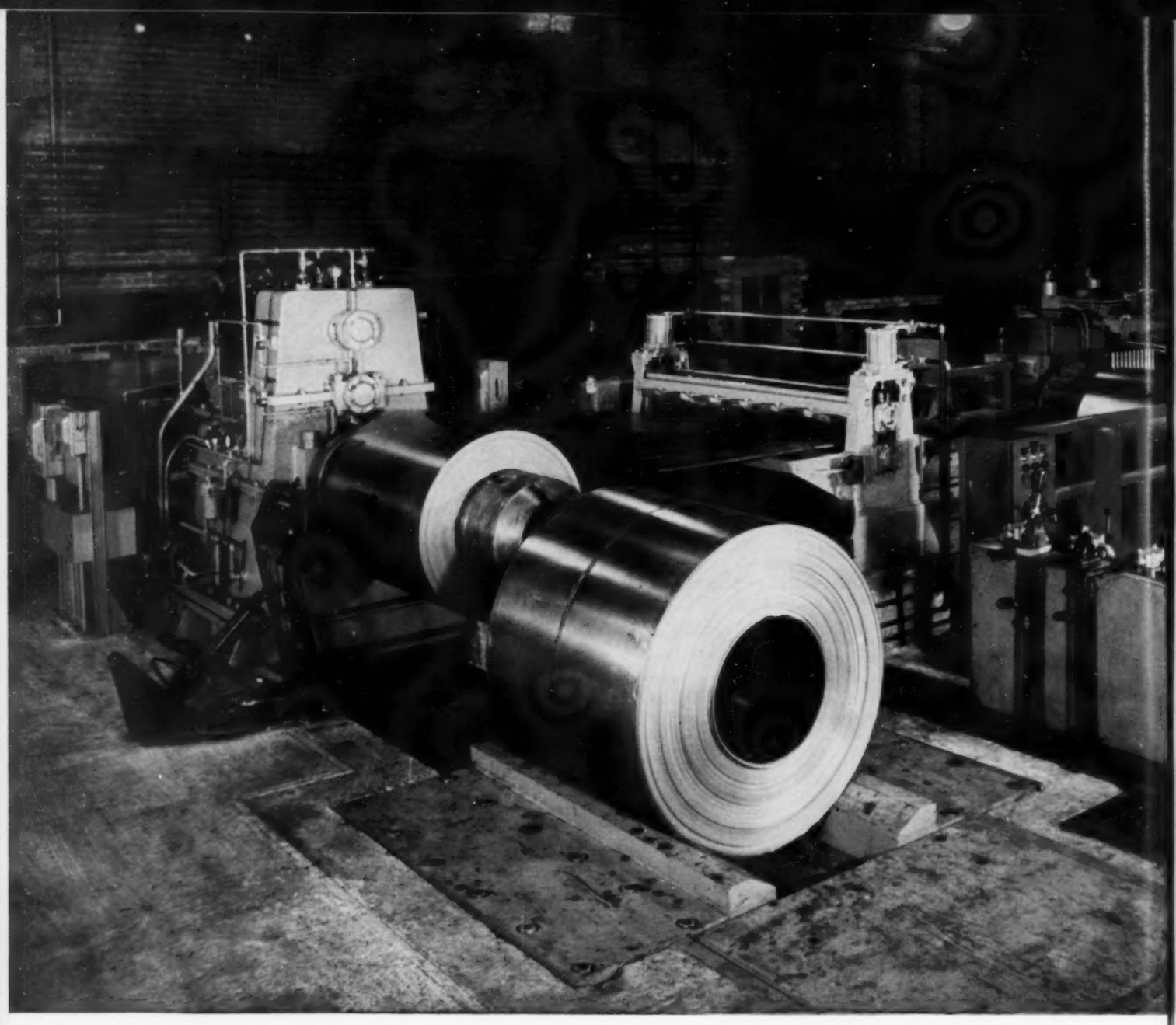
BROWN INSTRUMENTS

First in Controls



Wean Flying Shear Line (Entry End)

The WEAN ENGINEERING COMPANY, Inc.

WARREN ---------- OHIO

In the past decade steel making has made advancements in product development and production unmatched by any other industry.

The demand for better, more versatile steels, at rates that a few short years ago were beyond comprehension, has furnished the impetus. But the backbone of this tremendous revolution has been supplied by experienced metallurgists, who developed the materials, and engineering firms, like Wean, who designed and built the machinery necessary.

Equipment designed and built by Wean continues to establish performance records wherever it is in operation. This is the kind of progress that causes leading steel producers the world over to make certain they talk with Wean before they buy.

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Iron and Steel ENGINEER

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MOORE RAPID

WHEN YOU MELT... *Lectromelt*

ROLLING OF SHAPES in alloy and tool steel grades

By E. E. DAVIS
Superintendent of the Hot Mills
and
A. H. HIGHLEY
Assistant Superintendent of the Hot Mills
and Roll Designer
The Carpenter Steel Co.
Reading, Pa.

ERNEST E. DAVIS

A. H. HIGHLEY

. . . . in rolling specialty steels, a pass design for a given section may produce the desired shape in one alloy grade . . . . other alloys often require a different pass design for the same section . . . .it is thus necessary to obtain close cooperation between the operating, metallurgical and sales departments to specify the most economical shape for the customer . . . .

▲ THE need for greater economy in the manufacture of machined parts has increased the use of hot rolled alloy shapes. Greater use of high grade alloys and tool steels in the industry has been found necessary to meet the requirements of higher powered machinery. This is particularly true of the industrial fields where there is need for heat resisting steels. Then, too, the increased cost of these alloys and tool steels over the last several years has caused a greater need for economy in the manufacture of parts made from these steels.

The number of the various alloys has increased due to the activity of the metallurgists who are devising new steels in order to meet these exacting requirements. This means that the rolling mill itself must be very flexible in its operation and pass design in order to roll these steels in the most economical and trouble-free way possible. Each of these alloy steels has its own characteristics, all of which enter into the design of a section for rolling into shape. Indeed, even the initial roughing passes may be different for many of these steels.

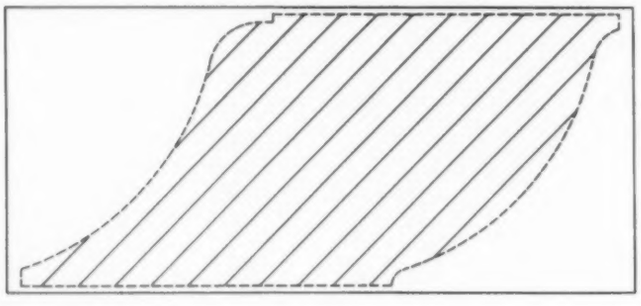
Because the economies to the customer must be such as to enable him to use shape sections, these sections must meet his requirements as to size tolerances and surface. This means that the entire rolling operation must be controlled from start to finish. Because of the different rolling characteristics of these alloys, controlling the operation puts a big burden on the roll designer. He must keep his rolling procedures as flexible as possible. The flexibility being there, if found necessary to avoid checks or slivers, it would be a small thing to change from one procedure to another without much delay.

The authors will cover the following items in this paper: (1) the reasons for customers desiring shape instead of rectangular sections; (2) a step-by-step procedure of how a shape is processed from the initial customer's print to the finished product from the rolling mill; (3) the difference in pass design that might occur through the use of different alloy steels; (4) the importance of guides and guide setups; (5) some typical hot mill alloy and tool steel sections.

Figure 1 shows the economies involved when using a hot rolled shape section instead of a rectangular or fluted square section. The white area shows the amount of metal removed from a rectangular section compared with the much smaller amount removed by using a shaped section. The increased efficiency of machine

tools and machining processes allows a greater use of shape sections. Close control of the entire rolling process is necessary from the initial roll design through the heating of the billets, to the actual rolling of the section on the hot mill. This is apparent when one considers the very small amount of metal that is to be removed from the section to manufacture the final product. As little as 0.015 in. is allowed on many grades and sections for machining. This means that tolerances must be very close and the surface must be entirely free from seams, scabs, scale marks and overfills. The method of machining a piece in the customer's plant must also be taken into consideration in designing a section. This means that the mill personnel should be in close contact with the customer. The best results are obtained when direct contact can be made. The success of any alloy section depends upon how well the section meets the customer's requirements.

The initial step in designing and rolling of a section starts with the receiving of the customer's print of the section he desires. Changes in the outline or the tolerances that must be met should be carefully gone over before proceeding with the pass design of the section. The first step in designing the section is to make a very accurate sketch on vellum. From there on the various passes are designed as the roll designer applies his art going back toward the initial billet. Each pass is drawn on vellum so as to superimpose one pass upon the other



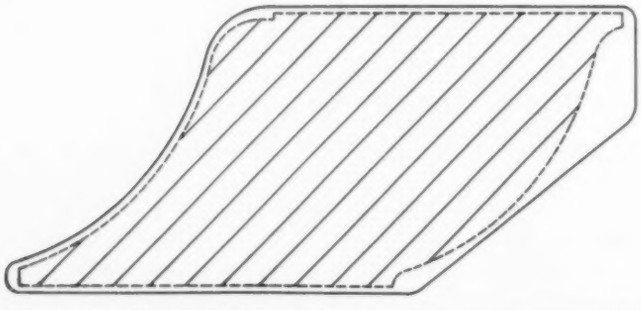


Figure 1 — A rolled shape will normally give economy to the fabricator.

to determine the amount of draft, spread and entry of the bar into each succeeding pass. These passes must be carefully scrutinized to avoid overfills that would cause laps and shearing. Drafts should be controlled to cause good delivery. Twisting of the bar in the pass must be avoided. This may cause twisting in the final section or strains which would mean twisting after a subsequent anneal.

After the pass sequence has been decided upon, dimensions of each pass must be determined. In making this step, shrinkage of the various types of steels must be taken into consideration. Shrinkage on these grades may vary from 0.012 to 0.025 in. to the inch. To make an accurate section, the shrinkage of the steel should be known before dimensioning the passes. This can only be determined by experience on the rolling mill itself.

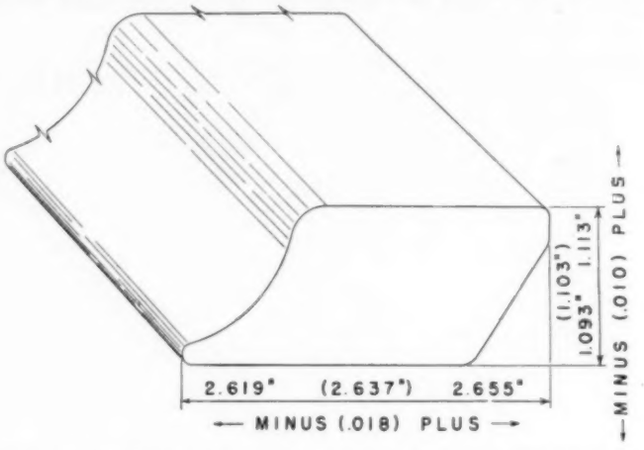


Figure 2 — Sketch gives an example of a typical tolerance.

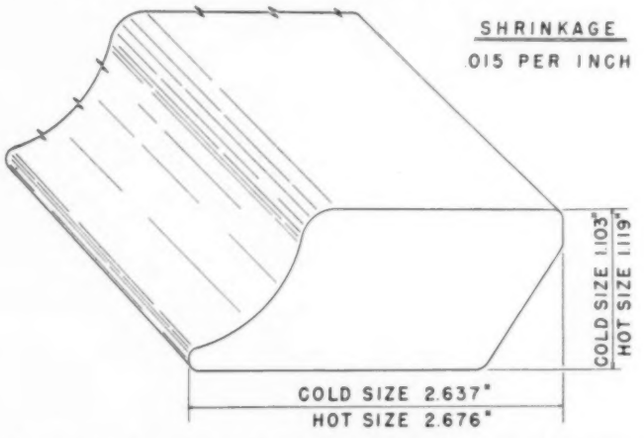


Figure 3 — In establishing roll pass dimensions, allowance must be made for contraction of the section due to temperature.

An illustration of how size tolerances and shrinkage tolerances are used can be shown by a typical alloy section. As shown on Figure 2 the maximum width tolerance is 2.655 in. and the minimum size is 2.619 in. The pass is designed to make the dimension 2.637 in. This allows the roller a plus or minus tolerance of 0.018 in. Thickness of the section is figured the same way. The maximum size is 1.113 in. the minimum being 1.093 in. and the size figured for 1.103 in. This allows the roller plus or minus 0.010 in. for this dimension. These dimensions are cold sizes. In this particular grade of steel which is Type 403, 0.015 in. per inch shrinkage is applied. Applying this shrinkage, the templates which are used to turn the passes will be filed to the following dimensions as shown on Figure 3. The width dimension which is 2.637 in. cold becomes 2.676 in. in the hot stage. The thickness dimension which is 1.103 in. cold becomes 1.119 in. in the hot stage. From these dimensions the templates are made and the next step in the process is to make the drawings of the various passes on the boards used to turn the rolls.

The roller or rollers who will be rolling these sections

are always consulted before final pass sequence is agreed upon and the rolls turned. Very often their interest will be shown by various suggestions which they may make regarding the rolling operation. By being a part of the design of the rolling procedure, the rollers will display much more cooperative and helpful attitudes than if they are left out of it.

After the pass design is agreed upon, templates are made for each pass from the finished to the initial forming pass. These templates must be very accurate because from these the tools are ground to cut the rolls.

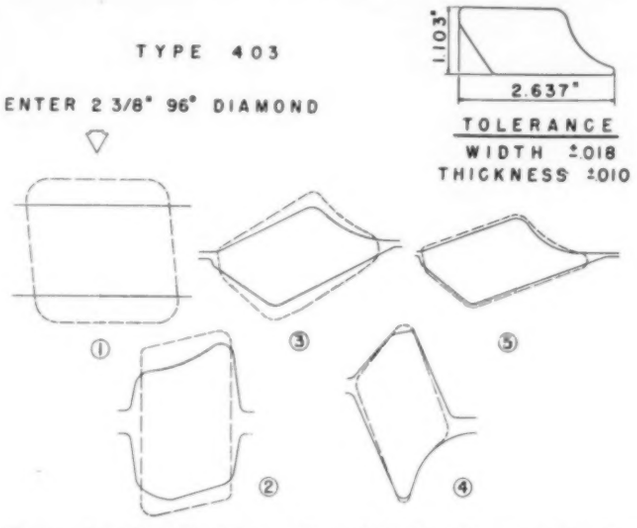


Figure 4 — Sketch shows roll design of section when using Type 403 steel.

The complete roll design of this section is shown on Figure 4. The surface of this particular section must be very clean, therefore, a billet large enough to be planished is used. After the planishing, the billet is broken down further in the roughing process to obtain the desired starting square, in this case a 2⅜ in., 96 degree open square. Because of the shape desired, one pass through the 96 degree groove will give the desired starting size. The diamond is then given a flat pass which produces a long cornered rectangular section 1 7/16 x 2⅞ in. This section is then entered into the first former pass and from there into another leader, an edge and then a finishing pass. The rolls for this particular section were 10½ x 24 in. size for the leader passes and 10½ x 18 in. size for the finishing.

Figure 5 — A pipe rack with a sliding rest bar in which the rolls can be placed helps in making the guides.

After the rolls have been completely turned, the next step is to make guides and fix-ups for the passes. To aid in this job a pipe rack which holds the three rolls in

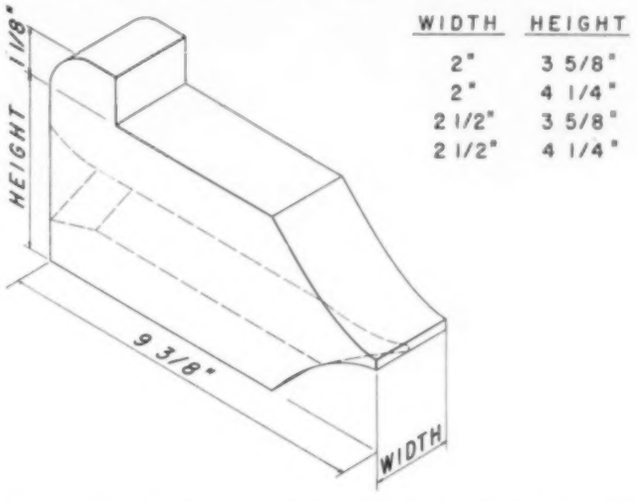


Figure 6 — Blank guide castings for entry guide shown is made in four sizes.

line and has a sliding rest-bar on each side of the rack is used (Figure 5). The rolls are lined up with the proper spring by means of shims. Simulated rest-bars are held in place by set-screws. Templates are used to obtain the proper alinement. Delivery and entry guides are machined and ground to fit the rolls on this rack. To

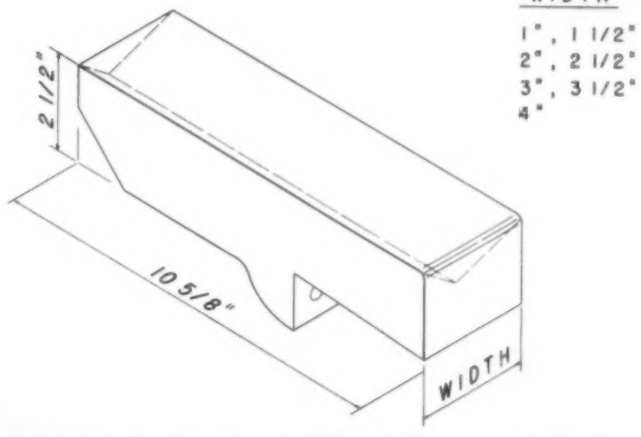


Figure 7 — Blank guide castings for delivery guide is made in four sizes.

facilitate the speed in setting up the shape, blank castings are used and then machined to fit. Figure 6 shows various sizes of blank castings used for entry guides. As can be seen a number of various sizes are used ranging from 2 x 3⅝ in. high to 2½ x 4¼ in. high. Figure 7 shows the dimensions of blanks used to make delivery guides. Here again, various sizes are used ranging from 1 in. wide to 4 in. wide. These castings, like the entry blanks, are kept in stock to save time in setting up a new shape. Where the production and tonnages are great enough and there is time, a pattern is made of the guide and castings made directly from the pattern.

Figure 8 shows an entry guide fix-up. These are very important when rolling shape, particularly in the alloy grades. Many alloy grades have a tendency to pick-up on the guides. This must be avoided because of the detrimental effect on the surface of the bar. At the same time, a guide must be hard enough to withstand wear. Guides may not scratch so that during the rolling op-

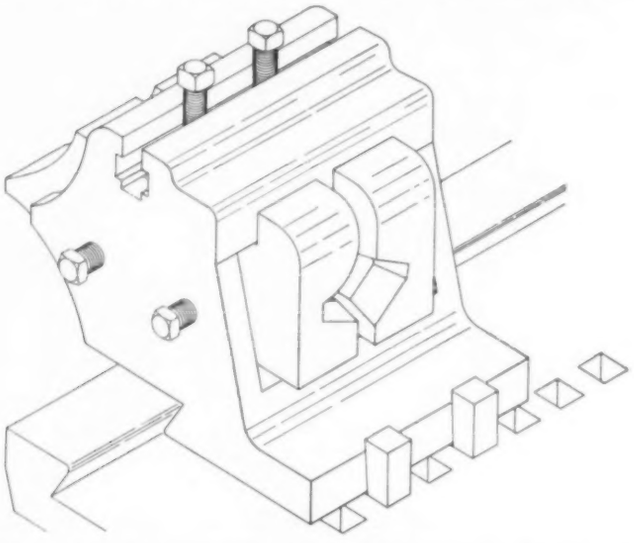


Figure 8 — Entry guide box assemblies are a very important factor in rolling shapes in alloy grades.

eration, a form of graphite, grease and oil combination should be used to keep the guides lubricated. Very often if the alloy or tool steel which is being rolled is not one that causes pick-up easily and the pass must be forced, a hard-facing guide may be used to avoid undue wear. Figure 9 shows a double-sided forcing guide. The vertical lines show where the hard-facing material is placed on a steel guide. There are various grades of

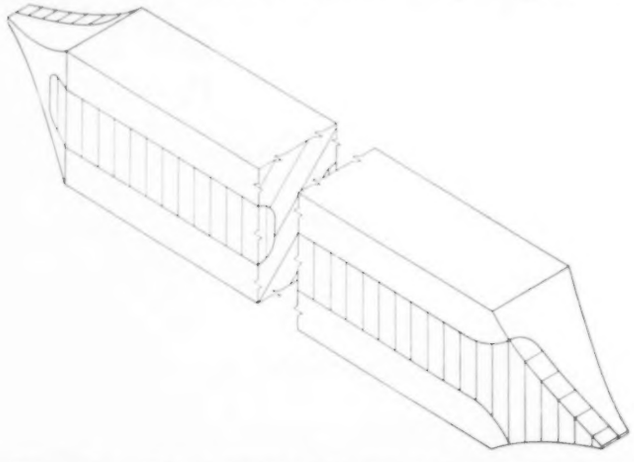


Figure 9 — This forcing guide has a hard-facing insert.

hard-facing that may be applied depending upon how hard the surface must be. The application of hard-facing to a guide must be done with great care, and the guide itself must be ground before being put into use. Pits or gas pockets in the surface of the hard-faced guide must be avoided to prevent scratching.

In order to insure that the section as rolled is within customer tolerances and surface requirements, a trial bar is cut and accurately gaged. A slide gage is used to show how close the section is to size. Figure 10 shows this type of gage. By holding the gage, with a piece of the shaped section in it, in front of a light, any difference in contour becomes quite noticeable. The test piece is also accurately gaged by micrometers, filed and acid etched to show any laps, lines or surface defects that might not be apparent in the hot stage. During the setting up process, test bars using the same material as the finished section are used to determine if the pass design and the guide set-up are accurate. During this process, the material itself is held back and not charged into the furnaces until a reasonable time has elapsed to show that the setup is correct. This allows accurate heating and freedom from scale defects.

There are many methods of roll pass design that will produce the same sections with properly shaped contours. When dealing with alloy steels, certain pass de-

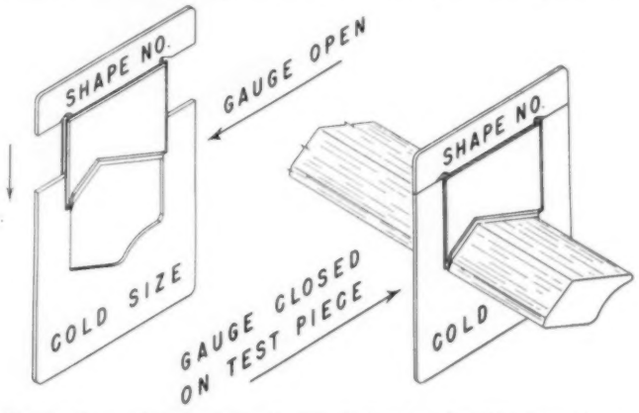


Figure 10 — Shape gage shown helps in checking sections.

signs will accomplish better section surfaces and physical properties than others. The one design that gives the customer the best surface and physical properties is the one that should be used. How the change in type of steels used in rolling a section will affect pass design can be shown in Figures 11 and 12.

Figure 11 is a pass design for a U-bar section that was used many years ago and proved very successful when used to roll SAE-2512 steel. Many tons of this steel were rolled using this pass sequence. Some years ago when Type 403 was developed by the metallurgists, the customer switched from 2512 to Type 403. This pass design which is a tongue-and-groove design then proved very unsatisfactory for Type 403. As can be seen, the legs of the section are isolated from the main portion of the bar in all passes but one. In rolling, these leg portions became very much colder and consequently less rollable than the heavier sections of the bar. This means that there were strains set up between the legs and the main portions of the bar. This action caused cracks and checking of the leg sections. This, of course, was very undesirable to the customer so that a new pass design was formulated to roll this particular section.

The new pass design is shown on Figure 12. This proved to be very satisfactory for producing a very accurate section from this type of steel. It also produced the section in a fewer number of passes.

The authors have found that tongue-and-groove passes are not very satisfactory when used to roll stainless and alloy grades.

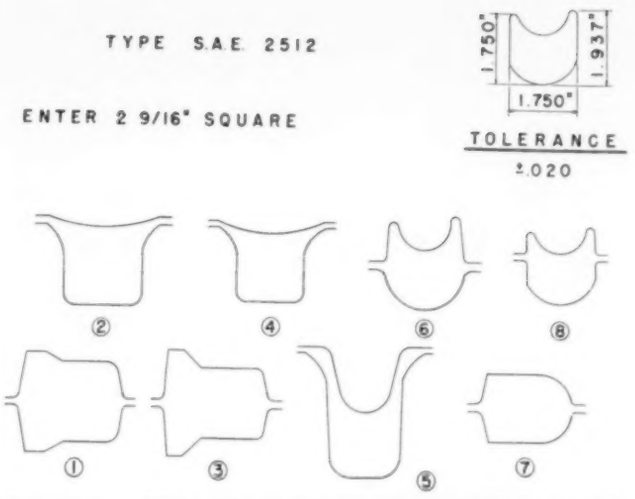


Figure 11 — This pass design works successfully on this "U"-section when rolled with Type 2512 steel.

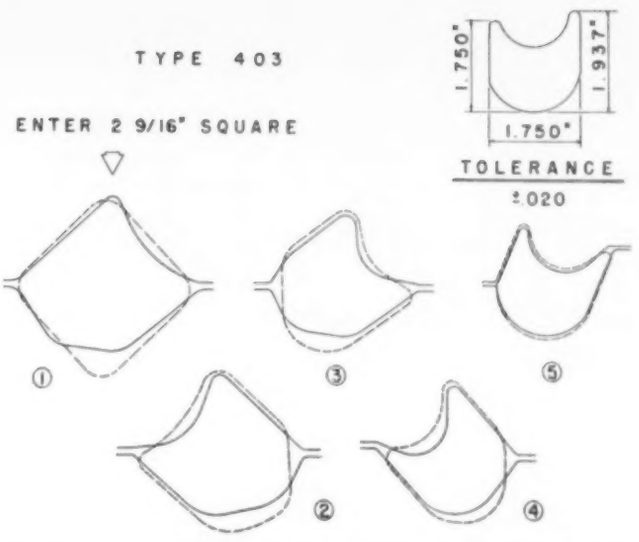


Figure 12 — It was necessary to revise the pass design for the "U"-section when rolled with Type 403 steel.

Figure 13 shows a pass design for a fuel nozzle section used in the aircraft industry. This was rolled in Type 347 steel. The surface of the shape contour had to be perfectly clean. All machining was done on the flat side. This section rolled very well.

Sometimes a customer will find after receiving hot rolled shapes that he can change his manufacturing procedure to take advantage of every possible factor in the section. Figure 14 shows such a procedure. Section A was designed to be hot rolled and then to be cold drawn to give the customer a closer tolerance and smoother surfaced bar. After finding out what the hot rolled section was like, it was decided that the surface was good enough and the tolerance was close enough so as to dispense with the cold drawing operation. Then B section was designed so as to eliminate cold drawing. Figure 15 shows the complete pass design for this section rolled in Type 405 stock. It is of the open pass design used for this type of material to prevent scuffing and slivers which would be detrimental to the surface quality.

One of the most interesting of shape rolling tool steel grades is the rolling of lawn-mower sections. Figure 16 shows a general design of a lawn-mower section rolled in SAE-3300 steel.

Tool steel sections must be rolled with the greatest of care and control. Surfaces may not be decarburized. To prevent this, billets for rolling must be charged and brought up to heat rapidly and rolled immediately after reaching rolling temperature. The pass design should be such that the passes are well filled. In this section, the bar is finished with a fin on the lip end. This is done for two reasons; one is that in the subsequent sharpening of the blade, the fin, which is very thin, is ground off leaving a sharp edge free from decarburization. The other reason is that the "spring" of the rolls, as the bar is entered, prevents the rolling of a dead-sharp edge. This means that without the fin, more stock must be removed to produce the sharp edge on the finished product because of the rounded corner on the hot rolled section. Thus, a fin causes a saving in costly machining. Much mutual benefit to both the producer and the customer can be accomplished when the mill personnel is familiar with the customer's proc-

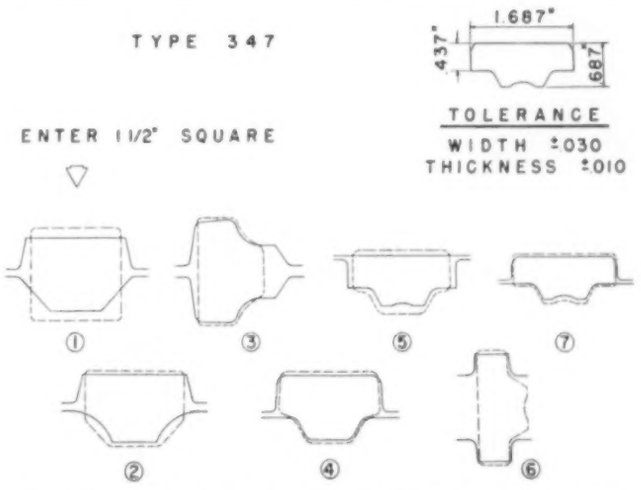
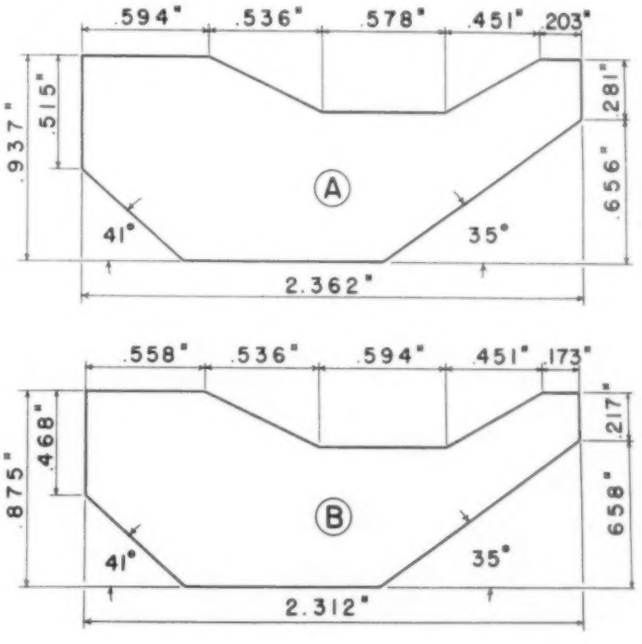


Figure 13 — Pass design shown is for fuel nozzle section.

Figure 14 — Revision of section from A to B eliminated cold drawing operation.



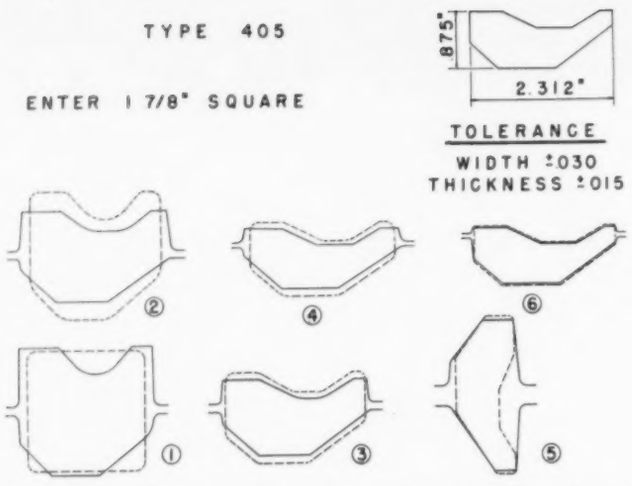


Figure 15 — These passes were used to roll sections shown in Figure 14.

essing. An alert sales department is cognizant of this fact.

Figure 17 shows the mill in which the sections have been rolled. It is a 7-stand, 10-in. mill having a roughing stand using 10 x 30 in. rolls and a strand set using the same. These are followed by four 10 x 24 in. stands. The finishing set uses 10 x 18-in. rolls. Sections as large as 15.64 lb to the ft, with a cross-sectional area of 4.59 sq in., have been rolled on this mill. Many variations

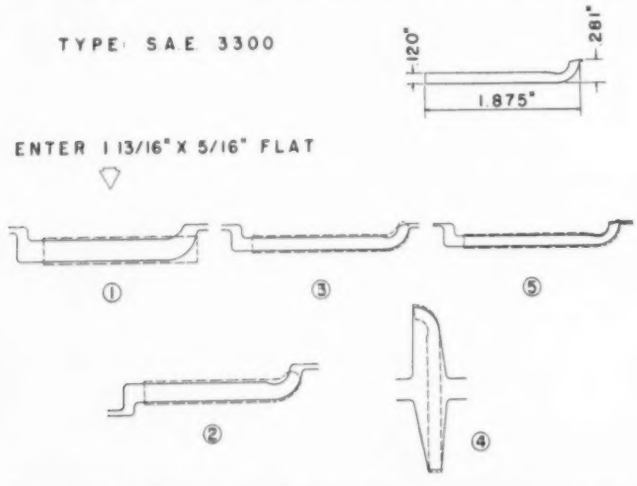


Figure 16 — Sections such as tool steel section for a lawnmower must be rolled with care and control.

exist in the mills throughout the country where specialty steels are rolled into shape. This is particularly true where small tonnages are rolled.

Many different roll pass designs can be used to produce a section with the proper contours. In the rolling of specialty steels, however, a pass design for a given section may produce the proper finished shape in one alloy grade, but if another alloy were to be rolled through the same pass design, the section would very probably be either off-size, out-of-shape, or subject to surface imperfections.

The great differences in hot rolling characteristics in regards to spread and elongation, make the pass design for shaped sections in the higher alloyed steels very intriguing.

Because of these many ramifications, it is necessary to have the closest cooperation between the operating department that makes the shaped section, the metallurgical department who specifies the alloy to be used on the job, and the sales department who makes the contact with the customer.

DISCUSSION

PRESENTED BY

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E. C. PETERSON, Engineer, Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa.

L. W. KING, Roll Designer — Manager Roll Sales, Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa.

JOHN A. ARCHER, Roll and Guide Designer, Crucible Steel Co. of America, Harrison, N. J.

ROBERT S. FINK, Superintendent Rolling Mills, Crucible Steel Co. of America, Pittsburgh, Pa.

E. E. DAVIS, Superintendent of the Hot Mills, The Carpenter Steel Co., Reading, Pa.

A. M. Cameron: It was stated that the roll designer must keep the rolling procedure as flexible as possible. I would like elaboration on this.

A. H. Highley: To elaborate on flexible roll pass design as has been requested by Mr. Cameron, a roll pass design that has more than one sequence of passes and can be used to produce the same section, such as diamond, square or oval square, I would call flexible.

A roll pass design for shapes to be flexible is one that enables the roller to make adjustments on any one particular pass without affecting the other.

A. M. Steever: I would like to ask if the author has had any difficulty in rolling special shapes of the new sulphurized high speed or high alloyed steels. By this I mean high speed and other high alloyed steels with 0.10 to 0.15 per cent sulphur.

Edgar M. Herold: The two designs that the authors showed for rolling a U-bar section from 2512 and 403 are quite different and the logical question is: "Can the analysis of the steel make that much difference"? The authors say: "Yes." The next question is then either "How" or "Why." I am not going to attempt to answer either question but I do want to point out some factors that may seem obvious at first glance.

We have learned from the metallurgists the properties that various alloys impart to steel. Sometime ago I raised the question as to whether alloys imparted their properties to steel exactly as the metallurgists say in the temperature range of say 1500-2000 F.

Let us look at the analysis of these two grades of steel:

Figure 17 — Mill used is a 7-stand, 10-in. unit.

2512

C	Mn	P	S	Si	Ni
0.09/0.14	0.45/60	0.025	0.025	0.20/–0.35	4.75/5.75

403

C	Mn	P	S	Si	Cr
0.15 max	1.00 max	0.04 max	0.03 max	0.50 max	11.50/13.00

Chrome increases resistance to deformation. The 403 grade has 11.50/13.00 chrome while the 2512 has none. With 0.15 carbon max in 403 and 0.09 to 0.14 in 2512 these elements are practically the same in both grades. Manganese tends to make steel more rollable and with 1.00 max in 403 with 0.45/60 in 2512 this element tends to balance itself in the two grades. There is no nickel in 403 and since one of the properties of this element is to enhance the effect of other alloys, the nickel may enhance the rollability that the manganese imparts to the steel and thus make the 2512 grade more easily deformed.

From the foregoing we may explain why one grade resists deformation more than another resulting in cooling and cracking of the legs as explained in the paper.

Now if this is the case (I mean the resistance to deformation as pointed out according to the alloy content) then why can 403 be rolled in five passes while it takes eight passes to roll the same section from 2512 steel? I would like to ask the authors if they have tried to roll 2512 in the revised passes.

It is apparent that these alloys are not functioning in the hot state in the same manner that they do in the cold.

Data from "Steels for Elevated Temperatures Service" U.S.S.—1952 and ASTM Special Publication No. 124—1952 entitled "Elevated Temperature Properties of Stainless Steels" show the following results in hot tensile tests:

Temp, F	Tensile 2512	Tensile 403
1500	30,000	9000
1700	15,000	8500
1900	8000	5500
2100	5000	3000
2300	3000	1500

I believe we can infer from this that 403 is more malleable through the rolling temperature range than 2512 which can account for its being reduced more rapidly than the 2512.

I believe the author's experience with these two grades applied to the same rolled section shows that it is extremely difficult to look at a steel analysis and predict with any degree of certainty its action between rolls in the temperature range of 2200 to 1500 F.

A. H. Highley: To my knowledge, No. 2512 steel has never been rolled in this sequence of revised roll passes. I am of the opinion that No. 2512 steel would roll well and be less troublesome than Type 403 steel if rolled in the revised sequence of passes.

E. C. Peterson: I am not a roll designer and therefore am not qualified to comment on any of the various shapes of forming passes. I was, nevertheless, interested in this excellent paper and as the authors described the various techniques that they employ to control flow of metal in the passes I was led to wonder whether they are able to use, and do use, the speed of rolling, that is, the rpm of the mill, to help get the results in the flow of metal in the pass that they want to get.

L. W. King: Relative to the item in the paper dealing with the construction and employment of entering and delivery guides, would you be kind enough to ad-

vise us as to whether or not you have employed roller guides with the profile of the various sections machined in the roller?

John A. Archer: Does the author consider his change in design from working the flanges of the shape into dead holes as shown on Figure 11 to working the flanges in live holes as shown on Figure 12 the main factor of improving the rolling of this shape?

A. H. Highley: Referring to Figure 12, you will see that the passes used for rolling this section are quite different from those shown on the previous Figure 11. The passes shown on Figure 12 are designed to induce a proper uniform flow and reduction of steel. The edges are receiving adequate work reduction. You will note that balanced work is being applied both on the edges and body of the section. This prevents the legs or edges of the section from becoming cold and lagging behind. This lagging behind causes a cracked or tension torn section.

Robert S. Fink: I would like to question your one short paragraph dealing with the heating of alloys. While rolling procedure is of prime importance, it has been our experience that controlled furnace atmosphere is equally important. Do you use controlled furnace atmosphere to hold decarburization to a minimum and also to increase rollability of the higher alloys such as the austenitic stainless grades?

A. L. Cameron: I would like an explanation of checking.

A. H. Highley: Checking, especially corner checking can occur in the very early stages of working. When rolling high temperature alloys, the roll pass sequence that will induce the proper flow of metal is the one that should be used. As the edge portions of the bar become lower in temperature than the body, and consequently less ductile as the section elongates, it forces these colder, resisting edges to travel along. This stretching of the less ductile edges causes checks. By applying balanced work both on the body and edges, this troublesome checking can be avoided.

When scuffing occurs in any pass it will usually result in a slivered surface of the section. The use of tongue and groove passes when rolling high temperature alloys will produce slivers. Types 403 and 347 will check very readily if worked in the diamond square sequence. By using the oval square method this condition can usually be corrected.

E. E. Davis: On rolling high speed, sulphur types of steel, we do not roll those types into shapes as yet, so I can not give an answer on that. In answer to Mr. Peterson's question, we have found on some types of steel which are resistant to forming, in order to keep the temperature as high as possible, the mill should be run as fast as possible, just keeping in mind of course that the roughers have to handle the bar. Usually on a ten-inch mill of this type you can run 185 rpm and roll very well at that speed. We do not use speed of rolling as a factor in the forming of the passes.

Mr. King's question concerns roller guides. We have tried roller guides. On the delivery end they of course are no problem and work very well. On the entry side, however, we have used them and found one disadvantage, that is the line of contact between the bar and roller guide is too far back from the pass to allow a tight fix-up, so you will find it harder to hold the bar in place especially one of uneven contours, by using roller guides.

On the question on controlled atmospheres, we do not have them on these particular furnaces; however, I would say they would be of great advantage.

*Use Of Open Hearth Slag In Blast Furnaces, And Effect On Open Hearth Practices**

▲ THIS paper outlines the experience of United States Steel Corp.'s Duquesne Works in producing a more economical basic hot metal, which is as consistent in chemical analysis and physical temperature as that produced by the conventional blast furnace burden with little or no open hearth slag.

Early in 1954, the Duquesne Works decided to charge predetermined amounts of open hearth slag in the blast furnaces producing basic iron. The slag was prepared by sizing to 10 in. and under and the tap and flush slags were separated. One blast furnace used open hearth tap slag as only part of the burden; the second furnace's charge varied from ½ tap, ½ flush slag to ⅓ tap, ⅔ flush slag. During the past nine months, the amount of slag charged was steadily increased, until the total available quantity of open hearth slag has been completely consumed in the blast furnaces. This peak occurred at 66 per cent hot metal to ingots in the open hearth and 450 lb of open hearth slag per ton of iron produced in the blast furnaces.

Sulphur control in the open hearth using this type of iron is no longer a problem. Hot metal containing higher manganese and lower sulphur substantially aids in reducing the sulphur in the open hearth.

In the past, the use of such large quantities of open hearth slag in blast furnace burdens was considered undesirable. The subsequent use of such hot metal with higher phosphorus content in the open hearth furnaces required more careful control of temperature and slag, and imposed, as well, certain blast furnace problems. However, the potentialities of its use were attractive enough to warrant a restudy. As a result, at Duquesne Works, practices have been developed that permit such usage with no adverse effect on analyses or quality of finished steel, and gaining the economies from recovery of metallics and reduction in consumption of flux and manganese. Such a practice may not be suitable to the same extent at all plants.

Specificially, this practice does have the following advantages:

1. Recovers metallics in the form of oxides in the open hearth slag, and one by-product, of course, is the metallic scrap recovered, which otherwise is lost.

2. Reduces the limestone burden in the blast furnace.

3. Recirculates the manganese lost to the slag in the system, thereby making possible a substantial reduction in ferro-manganese addition to the steel under the specially controlled practice used at Duquesne.

*Abstract from paper by E. B. Speer, Assistant General Superintendent, U. S. Steel Corp., Duquesne, Pa., presented at Blast Furnace, Coke Oven and Raw Materials Conference, Philadelphia, Pa., April 19, 1955.

By ALFRED E. KADELL
Senior Vice President
Great Lakes Steel Corp.
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The author (center) chats with John H. Vohr, President of AISE and General Superintendent, U. S. Steel's Gary Works (left), and S. W. Ostrander, Vice President, Special Products, Ford Motor Co., at the reception preceding the Association's Spring Conference banquet. Mr. Kadell was guest speaker.

Steel Must Develop Executive Talent

. . . . these comments are an excerpt from a talk given at the informal stag dinner of the 1955 AISE Spring Conference, Detroit, Mich., April 26, 1955 . . . .

▲ IN Detroit, hardly a day goes by without the announcement of new automobile production records. Also, if one searches carefully enough he will even find an occasional statement in small print claiming that sales are breaking records too. We sincerely hope the latter is the case. At any rate, the spirit of bigger, better and more highly styled cars is always in the air. Detroit is wearing a broad smile these days, and is enjoying its newly found prosperity immensely.

The steel industry, in turn, reflects this tremendous burst of activity in automobile production with operating rates very close to capacity, a capacity which has been very much enlarged in recent years. It now begins to look as though further increased steelmaking capacity is needed to satisfy the demand, particularly in cold roll.

The present record-breaking activity in the automobile industry brings back to the minds of those of us who have been in the steel business that long, the period of growth and expansion in the 1920's. Then, a finishing mill producing around 15,000 tons of full finished sheets in a month was considered a very large operation. Today, we have many cold mills producing up to almost ten times that much in cold roll in a month. Industrial size commonly considered big 25 to 30 years ago is dwarfed in the light of present day size. Not only has industry expanded very largely its product capacities, but it has greatly enlarged its unit plant size. Technological developments and pressure to reduce costs have been largely responsible for these developments, but more capable management personnel has made it possible to do this successfully. The foreseeable future promises further growth along the same pattern, that is, bigger industry and larger unit plant size.

This pattern of growth has created in its wake many difficult problems for industry—particularly for heavy industry such as steel—and has altered radically the procedures employed in the management of such enterprises. From comparative simplicity in organizational structure, it has been forced into very complex arrangements. Today, for example, the labor relations division occupies an extremely important place in the conduct of business in an industry such as steel. In the days when the plant units were much smaller than now, there generally existed close contact between top supervision and labor. This made for close relationships which developed loyalties that made the han-

dl'ng of labor problems rather simple and direct. Job security to the average workman was very closely associated with profitable operations. Now, labor relations must be handled by specialists trained in labor law and labor contractual procedure.

An industrial engineering division is a necessary adjunct in every large industrial enterprise today. More accurate determinations must be made as to what constitutes a fair day's work and what a fair rate of pay for it should be. Job study for proper and adequate application of incentives must be made. Many other related functions are performed by this division.

Large engineering and construction staffs must be maintained to keep up with the need for constant expansion and modernization programs. Proper maintenance of present day complicated production equipment also requires considerable engineering help and advice.

Extensive and well rounded technical staffs are required for effective product and process control and development. The need to control quality of product so that the customer is kept satisfied at all times makes quality control and customer contact essential.

The many local, state and federal laws have compelled business and industry to employ very large clerical and accounting staffs.

The large plant operations in themselves require much more complex organizational structures. Maintenance of plant and equipment (extremely important today because of high speeds and complex design), control of plant processes for maximum yields and production volume, control of material flow, proper scheduling of orders for both prompt delivery and efficient operation are just a few of the all important items that must be done well.

The proper type of organization must be maintained to promulgate safety in all its aspects.

Public relations is still another feature in today's conduct of big business that cannot be overlooked.

All of these activities must be supervised and managed well to assure successful conduct of the business. This requires people with the proper capabilities and talents.

The search for this management talent is unceasing not only to get today's job done better, but also to supply organizational depth to provide for expansion, and to build continuity in performance for the future.

Management is not a permanent thing. In addition to the requirements of expansion, replacement needs are always impending due to losses through illness, old age and death. A reserve of adequate and capable replacements must be maintained at all times by building organizational depth.

Greater recognition than ever before is now being given to the self evident fact that, in a well run business, every supervisor must do his job well. This requires every executive to have the necessary qualifications to perform satisfactorily since that is essential to the development of good subordinate supervision. It is possibly true that innate ability appears on the scene now and then, but the number of such men available is far too small to satisfy the present and future needs. Recognition of this fact has led to the introduction and development in many organizations throughout the country of a number of systems aimed at discovering executive talent, developing it properly and using it effectively. It has been determined that the key to the successful operation of each of these systems has been finding satisfactory means of appraising ability in individuals. Many techniques have been devised for measuring management ability. By such means the abilities and potentialities of many individuals in an organization can be evaluated on a continuing basis. Thereby, the development and growth of the individual's potentialities comes under constant review and measurement. Despite some shortcomings in present practice, many benefits have been gained from these ability appraisal systems. People are better placed, more capable backer-ups are being chosen and the development of talent is being found more positive and effective.

Business and industry have grown rapidly in recent years and the number of management employees has multiplied to a very considerable degree. This has compounded executive personnel problems, and considerable difficulty has been experienced in improving techniques for handling management people in keeping with business expansion. Objective inventorying of executive talent has become more urgent as size and complexity have increased.

The pressure of events will most likely bring much improvement in present company practices in evaluating abilities and talents, since it is universally recognized that the most important asset of a business is its manpower talent. The need for more and capable executives in growing organizations is focusing attention upon effective means to develop management talent from within. As long ago as 1936, a prominent personage in the business world put his finger on this need when he stated: "The crux of the situation is not so much the need for men, nor the scarcity of proven leaders, as it is the failure of American business management generally to introduce an orderly and methodical system for the discovery, development and assignment of executive personnel." Quite a few years elapsed since this expression of opinion was made before orderly ability evaluation methods were first introduced, making possible better executive appraisal and manpower planning.

The return of vigorous competition in the past few years is forcing the improved use of executives. Very often the margin of competitive success or failure is tied in very closely with the quality of management talent. Experience indicates that the right personnel organized into an effective management team is essential to the continuing success of an enterprise.

We have dealt up to this point with the pressing need for properly qualified executive talent in business and industry, in general, and the coming into prominence in recent years of systems for discovering, appraising and developing executive talent. This great need for good executive talent is even more pressing in the steel industry. Continuation of population growth and the steady upward trend in per capita use of steel, not only in the United States but in the world as a whole, plainly indicate the necessity for continuing expansion of steelmaking in the future.

Operation of Magnetic Amplifier Controlled TANDEM MILLS

By J. C. PETH
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and

J. W. BRINKS
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. . . . magnetic amplifier control has operated very successfully on Pittsburgh Steel's new tandem mill unit . . . . this system has more components than control systems with rotating amplifiers . . . . however, maintenance on magnetic amplifier cores should be similar to that required by transformers and consequently less than that needed for rotating equipment . . . .

▲ THE tandem cold strip mill is the best example of the rapid advancement made in the electrification of the steel industry. In 1928, the first tandem cold reduction mill was installed with a total of 1020 hp on the four stands and the reel. This 32-in. wide mill had a maximum strip delivery speed of 340 fpm. Contrast that mill, having a common bus power supply without IR drop compensation, to present day mills having top rated speeds approaching 7500 fpm, total connected horsepower of about 25,000, and an individual supply generator system for each drive.

This increase in tandem cold strip mill speed and power has not come about in one large step. Rather, it has come about in small steps urged on by the demand for larger tonnages, higher quality, lower maintenance, and more efficient production.

While this paper is concerned with electrical drive equipment, it must be acknowledged that other than electrical developments have contributed much toward the improved production efficiency of the modern tandem cold strip mill. Mill builders have provided improved bearings, heavier mills, and better coil handling and auxiliary equipment. Strip lubrication and roll cooling techniques have advanced. Larger coils with better welds now come from the pickling lines. Mill operating personnel have kept pace by improving rolling and handling techniques.

Developments in electrical drive equipment have paralleled closely the developments mentioned above. The most significant developments in tandem mill control have been the introduction of IR drop compensation on common bus mills in 1940, the use of a separate generator supply system with rotating regulator control in 1947, and the use of complete 400-cycle magnetic amplifier regulating control in 1954. The need for, and the improvement resulting from, the first two developments have been presented before the AISE. The first tandem cold strip mill using complete 400-cycle magnetic amplifier regulating equipment went into operation at the Pittsburgh Steel Co.'s Allenport plant in March, 1954. In view of its highly successful operation, it seems appropriate at this time to discuss magnetic amplifier control and its performance in tandem mill regulating systems.

What is the magnetic amplifier and how does it work? Basically, it is a magnetic device for amplifying voltage and current. It provides a means of introducing a variable impedance into an a-c circuit through control of the saturation of its magnetic core. Dry type rectifiers added in series with the load convert the a-c output to d-c for controlling a generator or motor field.

The operation of the magnetic amplifier can be understood by referring to Figure 1 which shows a simple half-wave magnetic amplifier. Also shown are the idealized magnetization curve of its core material, and supply and output voltage conditions for different levels of control winding input. As the a-c supply voltage wave increases from zero, load current is initially pre-

vented from flowing through the load by the impedance of the magnetic amplifier, which is very high when the core is unsaturated. When the core becomes saturated, the impedance of the magnetic amplifier drops rapidly and the load current rises sharply to a level determined by the load resistance and the value of the supply voltage at that moment. As the voltage wave decreases, the current also decreases and becomes zero when the applied voltage wave reverses. During the negative half-cycle of the voltage wave, current is prevented from flowing by the rectifier in series with the load. Because of the steep magnetization curve, only a small d-c control current is required to saturate the core and thus make a big change in output. This high amplification makes the magnetic amplifier an unusually accurate and effective control device.

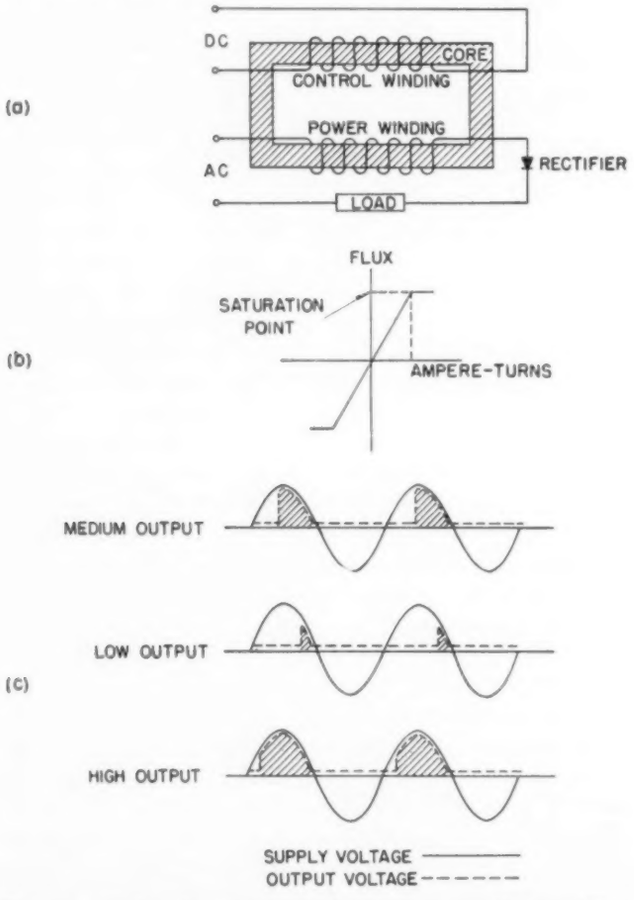


Figure 1 — An elementary half-wave magnetic amplifier with its idealized magnetization curve and wave form of its supply and output voltage is shown for several conditions of operation.

The elementary circuit in Figure 1 is not practical for general use for two reasons. First, the a-c supply frequency induces a high voltage in the control winding and causes objectionable circulating current to flow through this winding. Second, since only one rectifier is used, the current through the load occurs only once during each cycle, and consequently has a relatively low average value.

A more practical form of magnetic amplifier is shown in Figure 2. This is an elementary type of voltage regulator. The use of two cores minimizes the effect of induced voltages, since the two control windings are connected in opposition and any induced voltages tend to cancel each other. The generator field is connected in a rectifier bridge circuit so that full wave rectification occurs, and the average value of current is considerably higher than with the half-wave rectifier shown in Figure 1. Self-saturating rectifiers in series with each output winding cause the load current itself to aid in saturating the core, and thus increase amplification by reducing the ampere-turns required from the control winding.

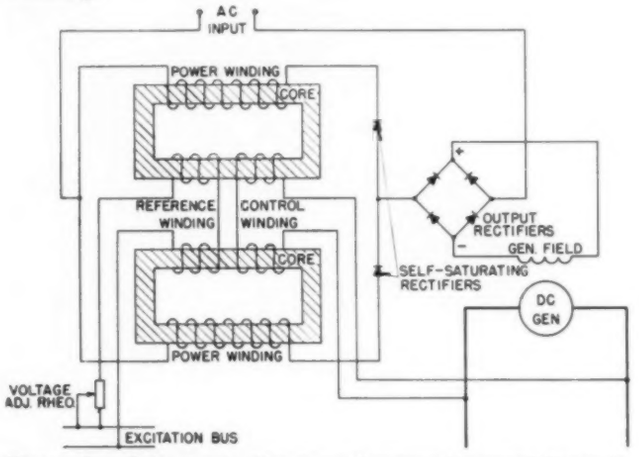


Figure 2 — Schematic diagram of magnetic amplifier voltage regulator.

Like all other regulators, whether mechanical, electronic, or rotating, the magnetic amplifier in a regulating system first compares the regulated quantity—voltage, current, speed, or tension—against a fixed reference. It then amplifies the difference between the two and corrects the regulated quantity so as to reduce the error between it and the standard.

In the voltage regulator, Figure 2, the reference winding serves as a standard of comparison. The control winding measures generator voltage and is connected so that its ampere-turns oppose those of the reference. A small difference in the strength of these windings will change the saturation of the magnetic cores and allow a proper corrective current to flow through the generator field, thereby causing its voltage to match the reference within close limits.

Certain regulator applications require greater amplification or higher power output than can be obtained with a single magnetic amplifier. Where this requirement exists, two magnetic amplifier units may be connected so that the output current from the first stage becomes the control current of the second. Such an arrangement is known as a two-stage magnetic amplifier. The tandem mill voltage regulator is a two-stage unit.

For applications requiring reversible regulator output, two magnetic amplifiers of opposite polarities may be used. Then the regulator will respond to positive or negative control signals in the manner shown on the combined transfer curve in Figure 3.

The development of the 400-cycle magnetic amplifier control system as used on the Pittsburgh Steel mill was started early in 1951. At that time there were installed thirty-odd tandem cold strip mills with individual stand generators having rotating regulator type control. Although those mills had been considered very successful in their operation, it was felt that the ever

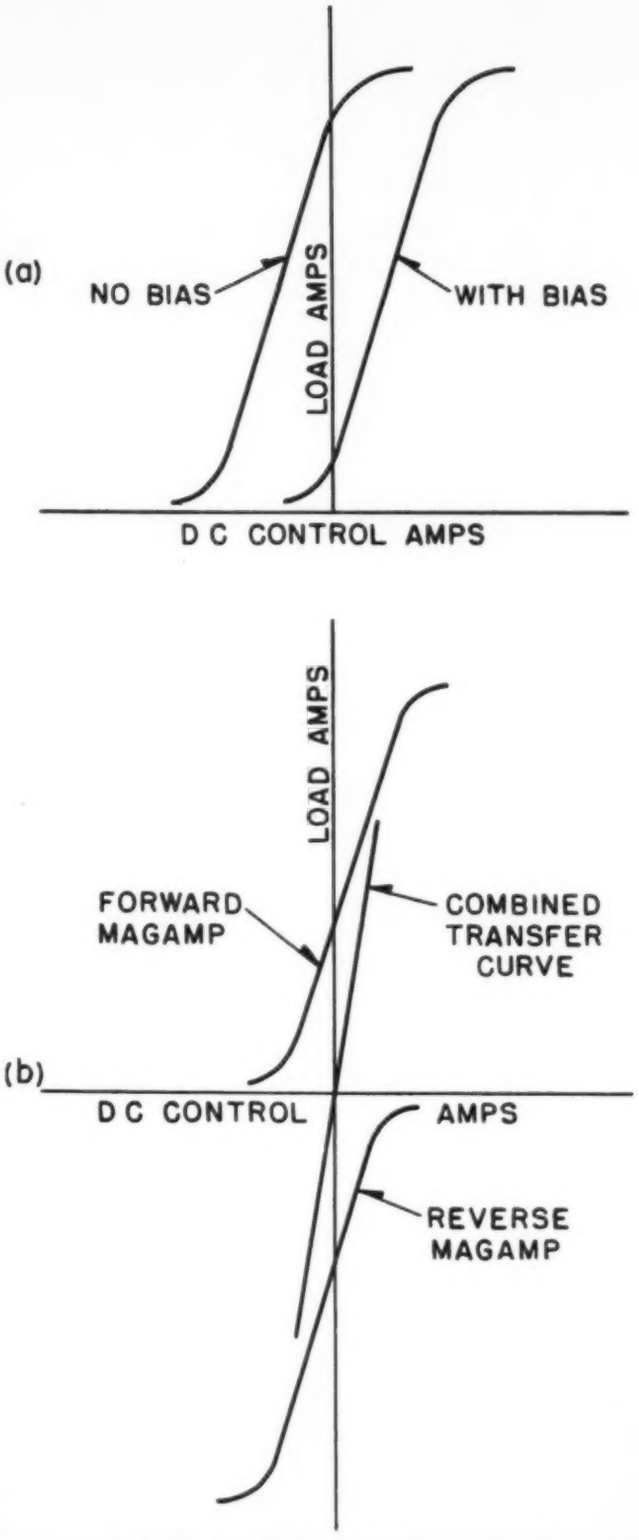


Figure 3 — Effect of bias and combined transfer curve of forward and reverse magnetic amplifier.

present demand for higher quality strip and lower maintenance required an investigation into the applicability of magnetic amplifiers to tandem mill control.

The development program was arranged so that the control system with both 60 and 400-cycle magnetic amplifiers could be studied. The early part of the program included an analog computer study of both systems. These studies indicated that the 400-cycle system should be close to the ultimate in performance, while the performance of the 60-cycle system should be only slightly better than the existing rotating regulator systems. Following the computer study, the necessary control and magnetic amplifier equipment was designed and built for a full scale combination test with an available 3600-kw generator and a 4000-hp double-armature motor—both designed for tandem mill service.

The 400-cycle magnetic amplifier control proved to be a voltage regulator of unusually high accuracy and fast, stable response. The voltage of the stand generator was caused to follow the reference bus voltage with a steady state error of less than 0.5 volt from zero to top voltage (750 volts). When IR drop compensation was added, the generator voltage was caused to vary from the reference bus voltage by the amount of IR compensation selected. This was accomplished by inserting the IR compensation signal in the error detecting voltage circuit.

The control elements (two stages of 400-cycle magnetic amplifiers) are extremely fast relative to the stand generator shunt field time constant. This, in regulator system parlance, approaches a single delay system, which requires no damping.

Because of the outstanding success of these tests, representatives of the metal working industries were invited to a demonstration of the 400-cycle system at the East Pittsburgh Works of Westinghouse in October 1951.

A few weeks after the demonstration, the Pittsburgh Steel Co. purchased electrical equipment for their new four-stand tandem cold strip mill. Four hundred cycle magnetic amplifier regulating equipment was specified.

This 66-in. wide mill, shown in Figure 4, has a maximum delivery speed of 3190 fpm with 21-in. work rolls. The winding reel mandrel is equipped with a gripper slot, but is normally threaded by means of a belt wrapper. Indicating tensiometer units are located between stands to give a continuous indication of strip tension. Located between the last stand and the winding reel is

Figure 4 — Pittsburgh Steel Co.'s new 66-in. four-stand tandem cold strip mill has a maximum delivery speed of about 3200 fpm.

an X-ray thickness gage. Aside from the usual thickness indicating instruments, the X-ray gage has an associated recording meter whose chart is driven at a speed proportional to the strip delivery speed. By this means any off-gage material may be located in the coil.

The physical arrangement of the mill and reel drives is shown in Figure 5. Each of the stands is driven by a twin-motor; the only mechanical tie between the motors being through the strip. Although twin drives have

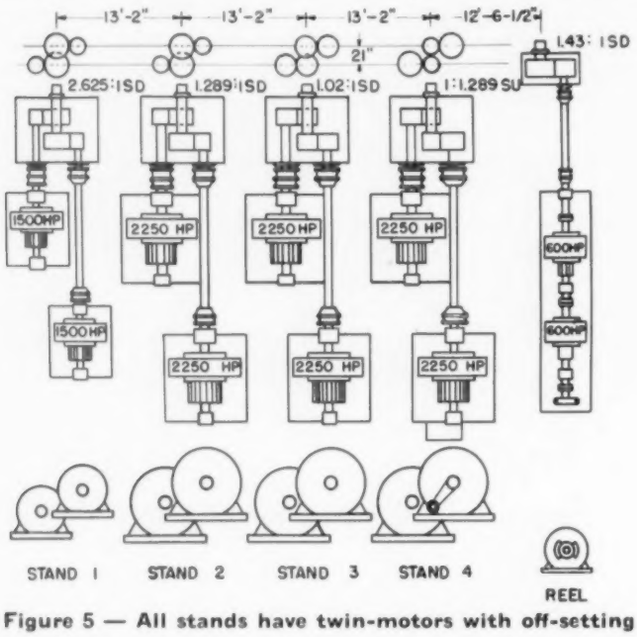


Figure 5 — All stands have twin-motors with off-setting gears.

been used many times for the later stands of tandem mills, this is the first mill to use twin-motor drives on all stands. The use of twin drives without interlocking gears obviates the necessity of matching work roll diameters, and it also permits the use of geared drives without pinion stands. (It is interesting to note that the two temper pass mills at Pittsburgh Steel also have twin-motor drives). The selection of the same horsepower ratings on the last three stands is a trend in the powering of recent four-stand mills. Figure 6 shows the reel and stand drives looking from the delivery end of the mill. The two power supply motor-generator sets may be seen at the left.

The master control, instrument, and exciter panels are shown in Figure 7. The recording meters are located on the back of the structure. One end of the row of magnetic amplifier cabinets is shown at the left, and the 400-cycle power supply motor-generator set is located in the left center of the picture.

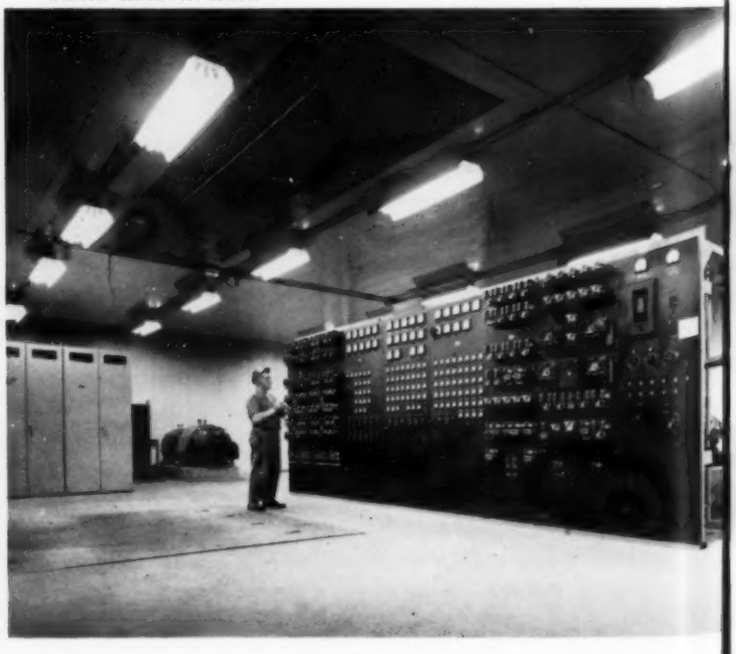
A separate magnetic amplifier cabinet is used for each stand, the reel, and the 400-cycle generator. Each cabinet is 40 in. wide, 32 in. deep, and 90 in. high, and is provided with hinged front and rear doors. Figure 8 shows the magnetic amplifier cabinet line-up with the front doors open on the cabinet for Stand 1. The neat well-spaced arrangement facilitates inspection and maintenance. The cabinets are ventilated with air from the main motor room cooling and recirculating system. The motor room arrangement is such that the backs of the cabinets are difficult to photograph, but Figure 9 shows the other side of one of these cabinets.

The cabinets and the magnetic amplifier components for all stands are duplicate even though the Stand 1 drive is a different rating from the others. Also, many of the components of the reel tension regulator and 400-cycle generator voltage regulator are the same as those of the stand voltage regulators. This results in considerable saving in spare parts inventory.

The magnetic amplifier cabinet line-up totals 240 in. in overall length. Including the 400-cycle, motor-generator set and three-foot aisle space in front and behind the cabinets for maintenance and inspection access, the floor area required is 222 sq ft. The magnetic amplifiers replace a total of eleven rotating regulators and five exciters used in a similar rotating regulator control. In the normal arrangement, these machines and their driving motors require a floor space of 328 sq ft. Thus, a regulator floor space saving of 33 per cent is realized

Figure 6 — Reel and stand drives are shown looking from delivery end.

Figure 7 — Master control and instrument panel for four-stand tandem mill.



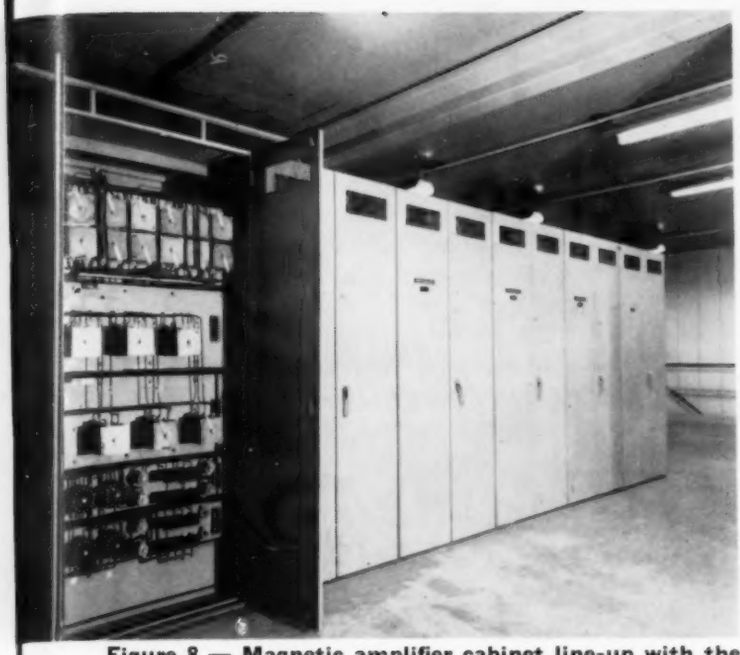


Figure 8 — Magnetic amplifier cabinet line-up with the doors open at the Stand No. 1 regulator.

with magnetic amplifier as compare l to rotating reg ulator control.

To become familiar with the tandem mill magnetic amplifier voltage regulator, it is best to visualize it as basically the same in block form as the rotating regulator system. For comparison purposes, refer to Figure 10, which shows a schematic circuit arrangement of both the rotating and magnetic amplifier regulator control for one stand. The similarity is obvious. In both cases, the voltage output of the main generator is bucked against a reference bus common to all stands, and any difference causes a corrective current in the control field. Both regulators are two-stage. Each stage steps up the power level and amplification of the signal. Provision is made for operating the generator at a voltage lower than the reference by means of a voltage lowering section on the rheostat. IR drop compensation is introduced directly into the control circuit.

One important difference between the two systems is that the rotating regulator system is essentially a two-delay system, and damping circuits are used to stabilize the regulator. As mentioned before, the magnetic amplifier regulator can be considered as a single delay system, which requires no damping.

Another obvious difference between the rotating regulator and magnetic amplifier basic circuits is that two generator fields—one forward and one reverse—are used in the magnetic amplifier system. This, of course, stems from the fact that the magnetic amplifier has unidirectional output. Forward and reverse channels are used; the forward channel controlling the forward field, and the reverse channel controlling the reverse field. Then, for any operating voltage, the algebraic sum of the ampere-turns in the forward and reverse fie'ds is the same as if a single field were used. The forward field is essentially the same design as would be used on a rotating regulator controlled generator. The reverse field, however, needs to have only about 20 per cent of the continuous ampere-turn capacity of the forward field, as this satisfies the operating cycle

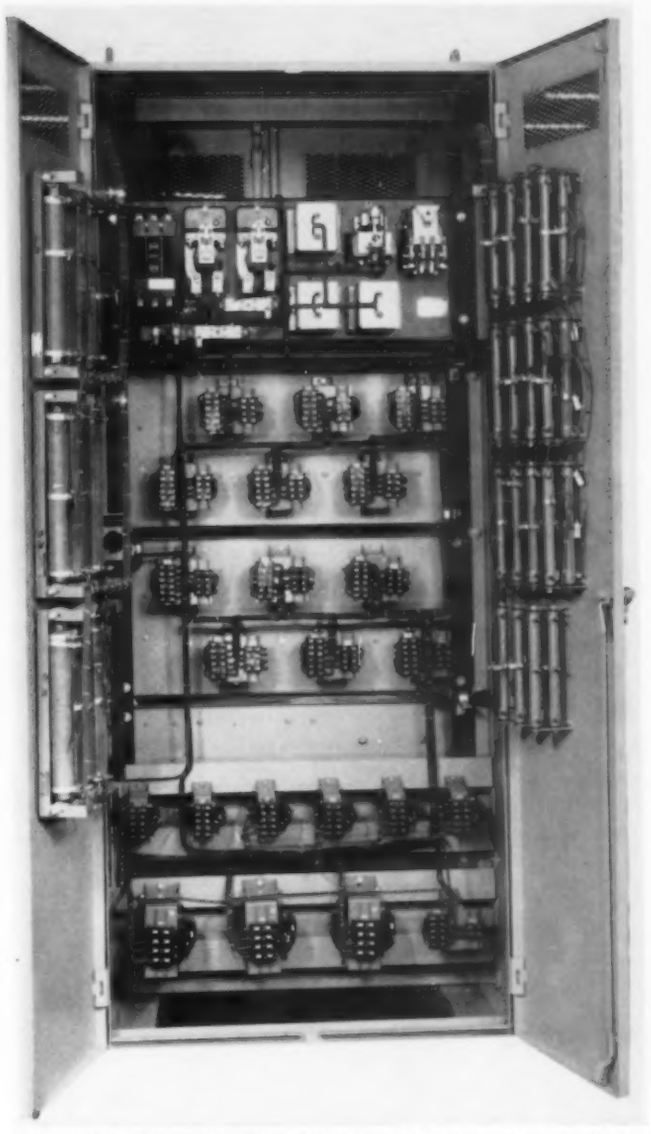
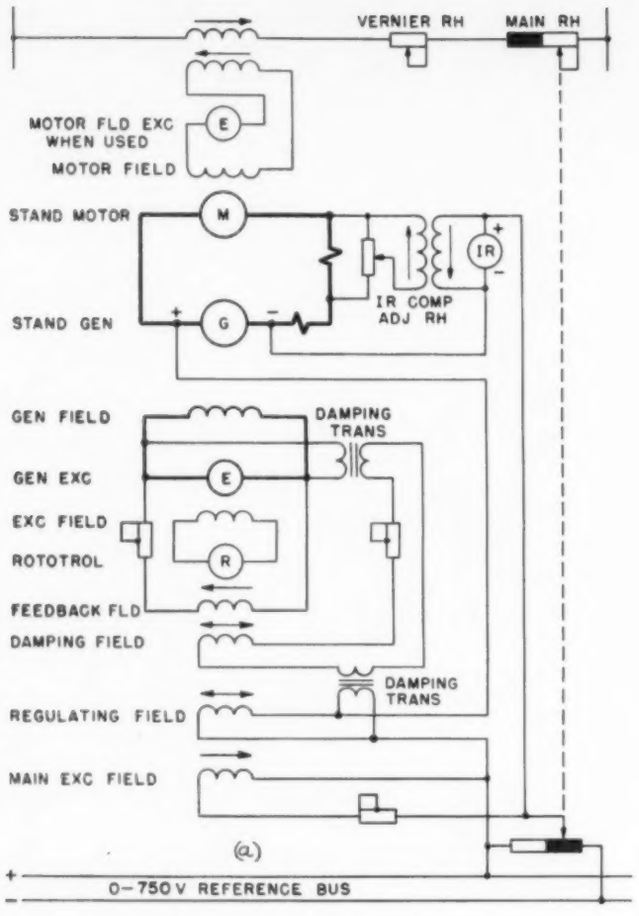


Figure 9 — Shop view shows interior of magnetic amplifier voltage regulator cabinet.

requirement. For such conditions as stopping at the maximum rate, or reverse jogging, the reverse field may be forced to several times its normal field current.

A forward and reverse (two-channel) magnetic amplifier may feed its output into a single output circuit as shown for the first stage magnetic amplifier. Why not use such a circuit to feed a single full capacity generator field and do away with the reverse field? There are two reasons:

1. The single output circuit requires the use of mixing resistors to provide a return path of current flow. These resistors absorb considerable power, reducing the efficiency to a maximum of 17 per cent as against an efficiency of 50 to 60 per cent in the case of independent forward and reverse output circuits. This extra resistor loss may run as high as 8 kw for a generator of the size used on this mill. This extra power loss must be dissipated. But of more importance is the fact that a magnetic amplifier of considerably larger size would have to be used. The mixing resistor circuit is used on the first stage output since the power level is only about one-fifth hundredth of that of



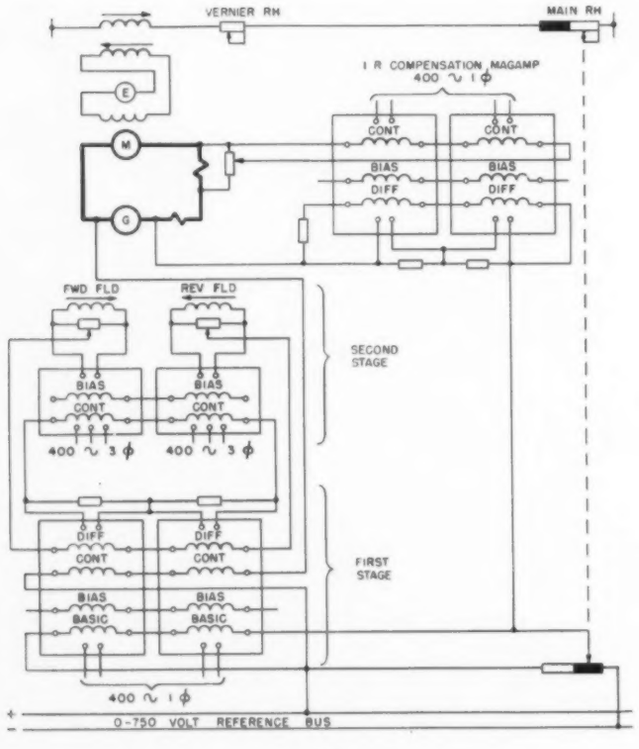


Figure 10 — Stand voltage regulators with rotating regulating machine and with magnetic amplifiers are compared.

the second stage. Hence, efficiency is of little consequence in the first stage.

2. On generators for general application, there might be some problem in providing ample field winding space for the reverse field. But tandem cold strip mills are provided with machines of very liberal designs. There is ample field space to accommodate both forward and reverse field windings.

The IR drop compensation is introduced in the control field circuit by means of a small two-channel magnetic amplifier. In addition to having faster response than a rotating machine, it also offers the advantage of having practically no residual voltage. This enables normal and emergency stopping without any tendency to rock or creep.

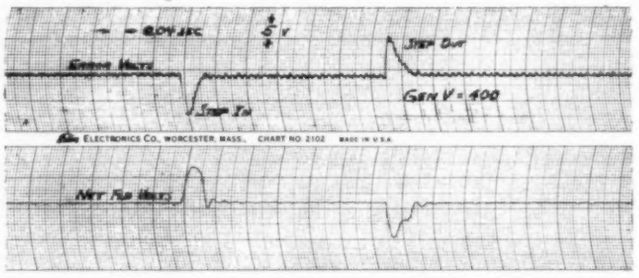


Figure 11 — Response of voltage regulator is shown for a 2 per cent step error in control field.

Final adjustment of tandem mill control is made in the field after the installation work has been completed. The regulating system is adjusted to provide performance characteristics which have been proven by experience on other mills to give optimum mill performance.

Some of the generator voltage regulator tests and indicated performance for the Pittsburgh Steel tandem mill are as follows:

1. *Response test*—This test is made by inserting an instantaneous error voltage into the first stage control winding by suddenly switching a battery in or out of the circuit, and recording the time required for the regulator to respond. This test, although much more stringent than any mill operating condition, serves as a measure of regulator performance. Figure 11 shows response test chart for 14-volt error in and out with the generator operating at 400 volts. Note that the full error has been corrected in less than 0.07 seconds in both cases. With the motor connected to the generator, the response is completed in 0.1 second whether operating at full or weakened motor field strength. The response for all stands is essentially the same. This is expected since all magnetic amplifier components are duplicate and all generator field time constants are of the same order of magnitude.
2. *Steady state tracking*—This test serves as a measure of the accuracy of the regulating system in causing the generator voltage to match the reference voltage at any steady state condition from zero to full voltage. Using a millivoltmeter to read the difference between the generator and reference voltage, the maximum error was observed to be 0.2 volt as the voltage was varied between

zero and 750 volts in steps. This high degree of accuracy is possible because of the high level of amplification of the regulating system.

3. *Difference volts*—It is necessary that the voltage between adjacent generators is closely matched not only during steady state running, but also during rapid acceleration and deceleration of the mill. To measure this difference voltage between stands, the oscillograph element was connected between two generator positive terminals, with the two negative terminals being tied together.

   Figure 12 shows a difference volt test for adjacent Stands 3 and 4 on a two-channel oscillograph chart. The lower trace shows reference bus voltage and the upper trace shows difference volts between Stands 3 and 4. The difference volts trace shows a steady rise to about 1.3 volts from threading voltage to full voltage with a short transient difference of 1.8 volts as full voltage is reached. The 1.3 volts difference is maintained during 750-volt operation, and it gradually decreases during the normal 7-sec deceleration. Next, the voltage was increased in steps. Then, the mill was brought to a two sec emergency stop. The fact that there is no transient disturbance in difference volts during this rapid voltage change indicates a very well-adjusted, stable, and fast response regulating system. If the transient response of the two stands had been different, it would have shown up here as a transient disturbance in the difference volts trace.

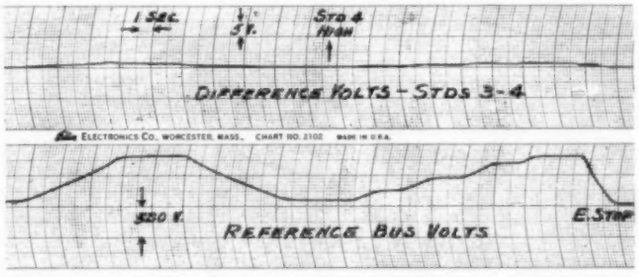


Figure 12 — The difference volts trace illustrates the well matched performance of two adjacent stands.

4. *Emergency stopping*—The tandem mill emergency stop must be made at the maximum rate consistent with machine commutating capacities. Obviously then, the mill can stop faster with the stand motors set at full field than at weak field because the torque per ampere is higher. For this reason, the rate of voltage change on emergency stop is made proportional to the field setting of the last stand. For this mill, the emergency stop rate is set for 2 sec at full field and 4½ sec at weak field.

   A further requirement on emergency stop is that the mill stands should not "rock" back or creep slowly when the reference voltage is brought to zero. With rotating regulator controlled mills, considerable adjustment time may be necessary to eliminate all traces of rocking or creeping on stop. The fact that this magnetic amplifier controlled mill stopped without any rocking or creeping without any field adjustment substantiates the high steady state accuracy and fast, well-damped response of the regulating system.

It is important to have a fast response, precise winding reel control. This mill is equipped with the basic reel control which for years has given the most stable and precise performance available on tandem mill reels. The principal difference between this control and that used earlier lies in the use of a complete 400-cycle magnetic amplifier regulating system.

The system consists of three regulators. First, there is a current regulator to control the reel generator to maintain constant strip tension by regulating the armature current. The current regulator must be accurate and have fast, stable response. With the high gain, small time delay, 400-cycle magnetic amplifier, such performance is easily achieved. Figure 13 shows the response characteristic of the current regulator. This was taken by setting the winding reel brake and introducing a step error from a battery source much the same as in the stand response test. The response is complete in 0.04 second.

The second regulator is a reel motor counter-emf regulator which maintains constant counter-emf during coil buildup by controlling motor field current. This regulator is accurate and very stable, but slow in response compared to the current regulator. The coil buildup changes slowly; therefore, the motor field current should change slowly. A change in motor field current for any reason other than a change in coil buildup results in an unwanted change in strip tension. This is the reason why the combination of a current regulator acting on the reel generator and the counter-emf regulator controlling motor field strength has proved to be the ideal combination for reel control. With a 400-cycle regulating system, high gain can be used to obtain accuracy, yet the system can be made very stable. In addition, the response time can be easily adjusted to the proper value.

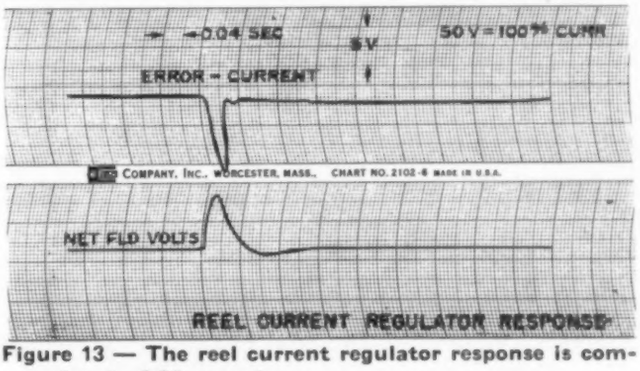


Figure 13 — The reel current regulator response is complete in 0.04 seconds.

The third regulator, for speed limit, controls the reel motor thread speed. This regulator uses several feedback signals so that a range of adjustment of speed difference between strip and reel is available to the operator. Thus, the operator can easily make the ideal threading adjustment for light or heavy strip. This speed difference is not changed by an adjustment of strip tension. The speed limit regulator is automatically overridden by the current regulator when the reel is threaded.

A magnetic amplifier regulating system similar to that used for the Pittsburgh Steel Company tandem

mill will be supplied for two other four-stand tandem cold strip mills now on order. One, for Alan Wood Steel Co., has a delivery speed of 2300 fpm and is scheduled for operation early in 1955. The second, for Empire Steel, is scheduled for operation in the summer of 1955, and it has a delivery speed of 1870 fpm.

The use of the magnetic amplifier regulating system results in a minimum of time required for final field adjustment. The principal reason for this is the inherent high gain and well-damped characteristics of the 400-cycle magnetic amplifier system. The test results shown in this paper illustrate the excellent performance of the regulating system. The operation of the Pittsburgh Steel mill to-date indicates that the 400-cycle magnetic amplifier regulating systems used on this mill are the best tandem mill regulators in the industry.

A brief review of the arrangement of the Pittsburgh motor room may be of interest. Figure 6 shows the very low headroom, as well as some of the ceiling and lighting details. This motor room was located about the middle of an existing building, with crane rails only 23 ft -6 in. above the floor. One end of the building contains the roll shop and the remainder is used principally for coil storage. To permit use of the 60-ton crane at either end of the building, the motor room height was restricted to 11 ft. In order to make the same crane available for lifts in the motor room, a roof was made removable. It consists of steel decking with overlapping joints, fastened down only sufficiently to withstand the slight air pressure in the room. Fluorescent lighting fixtures are also removable. They are mounted on uni-strut channels bolted to the ceiling and are plugged into receptacles mounted on the columns.

The usual routine inspection and clean-up during downtime has been scheduled; and, up to the present time, no maintenance problems have arisen.

In the opinion of the mill operators, there is no perceptible difference between the operation of this mill and others they have operated during constant speed operation. But there is a definite improvement during threading and during accelerating and decelerating periods. This mill is more responsive to operator's controls, and the tension builds up uniformly between stands during slowdowns. This results in the mill getting on gage quicker during acceleration and holding gage longer on slowdown.

As mentioned earlier in this paper, the regulator final adjustments were made in the field. Because construction was somewhat behind schedule and certain commitments had been made by the steel company's sales department, it was decided that the mill should be put in operation before the engineers had entirely completed their checkout. To the gratification of all, and possibly to the surprise of most, the first coil tried proved to be a saleable product. Some slight loss of reel tension during acceleration was observed in these early runs, but adjustments were made and the mill continued in operation for about a month. A planned shutdown was then arranged and the final adjustments were completed. No further adjustments have been required since that time.

DISCUSSION

PRESENTED BY

R. G. BEADLE, Application Engineer, Steel Mill Section, General Electric Co., Schenectady, N. Y.

H. A. LONG, Chief Engineer, Pittsburgh Steel Co., Allenport, Pa.

ARTHUR B. GLOVER, Superintendent Electrical Div., Acme Steel Co., Chicago, Ill.

J. W. BRINKS, Steel Mill Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

J. C. PETH, Chief Electrical Engineer, Pittsburgh Steel Co., Monessen, Pa.

R. G. Beadle: Regulating systems for tandem cold strip mills have been under constant development and improvement over the past several years and there have been many AISE papers on the subject. At the 1954 AISE Spring Conference in Philadelphia, a paper was presented by the writer which discussed and compared several types of tandem mill regulating systems. See May 1954 Iron and Steel Engineer. The performance of the all-magnetic amplifier regulator given in that paper agrees substantially with that reported by Messrs. Brinks and Peth.

I concur with Mr. Brinks that there are some definite advantages to a faster regulating system. (It must be remembered, however, that there are many mills now in service, with slower regulators which have an outstanding record.) However, it is important to point

Figure 14 — Good performance can be obtained through the use of a regulating system with magnetic and rotating amplifiers.

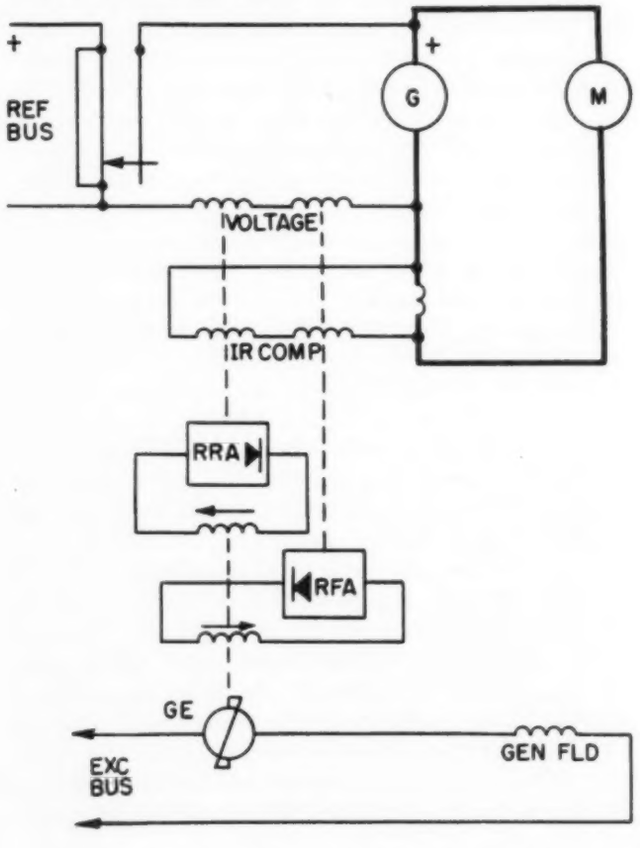


TABLE I

	Complete magnetic amplifier system	Combination system
Magnetic amplifiers	8 Single phase preamplifier 8 Single phase IR compensation units 8 Three phase power units	8 Single phase preamplifiers
Rotating amplifiers	None	4 Rotating regulators
High frequency supply	1 Alternator	1 Static frequency multiplier
Regulator for high frequency	1 Voltage regulator	None
Exciter	None	1 Master field exciter
Generator fields required	2 per generator	1 per generator

out that the fast response can be obtained without the use of a complete magnetic amplifier system. A regulating system with essentially equal performance can be obtained by using the combination of magnetic and rotating amplifiers.

An example of a combination regulating system is shown in Figure 14. This system uses two small magnetic amplifiers for the first stage while a rotating amplifier is used for the power amplifier. This system uses the two devices in such a way that the advantages of both are realized.

Since this combination system has approximately equal performance as the one described by Messrs. Brinks and Peth, perhaps they should be compared on the basis of complexity. Table I lists the components required by the stand voltage regulators for a 4-stand tandem mill.

Note the greater complexity of the all-magnetic amplifier system. It requires more small magnetic amplifiers, and even more important, it requires two large 3-phase power units to replace each rotating regulator. Because of the large size of these units, a high frequency alternator is required. In the combination system, the preamplifiers require so little power that a static high frequency supply may be used. For good performance, the alternator requires a voltage regulator while the static supply does not. Also the greater number of generator fields adds complication.

The comparison of the two systems really lies in the complexity of the devices, on the one hand a single rotating amplifier while on the other hand, two large power magnetic amplifiers as shown in Figure 10 of the paper. It appears that maintenance personnel will always have more difficulty understanding such a complicated device as large 3-phase magnetic amplifiers than understanding the familiar rotating amplifier.

In conclusion, I feel the question is not one of performance but one of complexity of the regulating system.

H. A. Long: Mr. Beadle touched on the item of maintenance. I know this was considered in selecting the equipment. We believe that the maintenance problem is of no more importance with the magnetic amplifiers than conventional equipment.

Arthur B. Glover: I am particularly interested in this subject as we are at the present time installing a cold mill in which we have a magnetic amplifier operating in conjunction with a rotating regulator.

When this mill was under consideration, we were offered various combinations of regulators. We went into the circuitry and simplicity of the various schemes, and due to the greater simplicity of circuitry we chose the combination of static and rotating regulators believing it was the simplest and most straightforward method of control. We feel that with our average run of motor inspectors—this combination will be easier to maintain and to shoot trouble on in case of malfunctioning.

J. W. Brinks: Mr. Beadle states that the performance of an all-magentic amplifier system and that of a combined magnetic amplifier and rotating regulator system are essentially equal. His company, no doubt, has laboratory computor tests or trial installation tests which show the performance of the combined rotating regulator and magnetic amplifier system, but, as yet, we have not seen these performance records.

As to the complexity of the all-magnetic amplifier system, mentioned by Mr. Beadle and Mr. Glover, it hardly seems a valid measure of system complexity to compare the number of magnetic amplifier units to the number of d-c rotating amplifiers. Which requires more maintenance—one d-c rotating machine or four dry type transformers, fixed mounted on a panel? The magnetic amplifier cores are very similar in construction to transformers.

There is absolutely no reason why maintenance personnel should have any trouble with magnetic amplifiers. Our customers have told us that where adequate installation, maintenance, and adjustment instructions are supplied they have no difficulty with this type of regulator.

It certainly seems fundamental that a rotating motor-generator set, requiring accurate machining of shafts and commutator, and brush, commutator, and bearing mantenance, requires more attention than a static magnetic amplifier with wound cores, and dry type rectifiers.

J. C. Peth: In the beginning we felt pretty much the same way Mr. Beadle does about the magnetic amplifier. None of us either in engineering or maintenance knew too much about it. We therefore started a series of evening classes for the men who were to be assigned to maintenance of this equipment. These same men were used as inspectors during the erection of the mill so that by the time we started up, they were all fairly familiar with the equipment.

The school was held two nights per week under the direction of our control engineer with considerable help from the electrical manufacturers' engineering and service personnel. We feel that this instruction was put over in pretty fair shape and that our organization can now handle the magnetic amplifier just as well as the rotating type of control.

CONTINUOUS CASTING at Atlas Steels, Ltd.

By JOHN F. BLACK
Manager Continuous Casting Section
Freyn Dept.
and
F. W. RYS
Assistant Manager
Freyn Dept.
Koppers Co., Inc.
Pittsburgh, Pa.

JOHN F. BLACK

F. W. RYS

. . . . continuous casting has proved itself an actual and practical reality . . . . it promises to eventually inaugurate a new era in steelmaking . . . . to some operations, particularly where existing equipment is not available, it may by-pass the blooming mill and soaking pits . . . .

▲ CONTINUOUS casting of molten steels has been an elusive target for the imaginative minds of forward-looking men of science and industry for well over one hundred years. The archives reveal the names of many who contributed to the development of the art and to the mechanism for continuously casting molten metal.

Based upon the Junghans-Rossi principle, the first commercial continuous casting machine for the casting of steels on this continent was recently put into operation at Atlas Steels Limited in Welland, Ontario. This casting machine is but one of a whole series of revolutionary steel-works installations brought into practical realization by the vision and aggressive courage of the Atlas Steels organization. The machine is designed for production of stainless slabs and fine quality tool and valve steels as well as for the carbon grades.

Let us first compare the principles of this continuous casting with the conventional methods of casting and rolling to equivalent dimensions. Until recently, the casting method in the steel mills has remained substantially unchanged from the early days of the steel industry. The steps include:

Tapping from furnace to bottom-pour ladle.
Transport to pouring area.
Pouring into static molds.
Stripping molds from the ingots.
Heating ingots.
Rolling ingots to desired shapes.

During rolling of the conventionally-cast ingot, losses from end-croppage and discard are of considerable magnitude.

In the continuous casting process, the metal is tapped from the melting furnace into an insulated, covered, lip-pouring ladle. This ladle is then taken to the top of the continuous casting machine and set into a tilting-cradle.

Since the subsequent pour usually requires more time than conventional bottom pouring, a high-velocity oil burner is mounted on the ladle to compensate for heat losses. Action of this burner also stirs the metal and helps to insure uniform composition. The metal is poured from the ladle into a special tundish or pouring box, from which it is discharged through a zirconium nozzle to the continuous casting mold below. The mold, made from a block of pure copper, is open-bottomed and water-cooled. A starting bar or dummy is inserted into the bottom of the mold prior to the beginning of a cast.

One of the basic principles of this process is the oscil-

lation of the mold. This oscillation is synchronized with the casting rate, and the downward and upward speeds of oscillation are at predetermined ratios to each other. The oscillation increases heat removal, and helps to keep the casting from sticking in the mold. At the same time a constant trickle of a vegetable oil down the inner side of the mold provides lubrication to the newly cast bar and the mold.

As pouring progresses, the starting bar with the new casting attached, moves downward and the virgin casting emerges from the bottom of the mold. Only enough solidification of the molten steel takes place in the mold to form a shell. Inside of this shell there remains a molten center or crater. Directly below the mold, the casting enters a box-frame, made of a series of small rolls. This frame is surrounded by riser pipes containing many small nozzles which constantly spray water on the casting to remove heat.

The basic purpose of the spray system is to cool the shell and thus cause complete solidification of the casting before it reaches cut-off level without damaging mechanical or metallurgical quality. Excessive cooling at any point in the system may cause cracking, breaking, deformation and rupture of the shell on some types of steel while insufficient cooling may cause failure of the shell through remelting.

The obvious solution to the conflicting requirements of fast cooling for quick solidification and high-production rates versus slow-cooling for quality, is dispersion of cooling over as great an area as possible.

Two sets of pinch rolls below the spray chamber have the function of supporting the casting and allowing its orderly withdrawal throughout the operation. The pinch rolls are actuated by the variable-speed drive which is synchronized with the cams that oscillate the mold.

Below the pinch rolls, the casting enters a ventilated cutting chamber and is cut into required lengths by oxy-acetylene torches. The torches are mounted on a carriage which clamps itself to and moves vertically with the casting during the cutting operation. The cut-off section is lowered into a discharge-pit and is transferred to a car which returns it to floor-level for collection and transfer to the rolling mill. The entire operation is automatic.

Advantages of the continuous casting process become apparent in making comparisons with conventional casting. The yield of metal is greatly increased. In many cases, it is possible to entirely eliminate the blooming mill process. As complete shops are designed and built with continuous cast billets flowing directly to heating furnaces, heating economies will result. Manpower requirements for continuous casting are comparable with conventional casting. From liquid metal to finished product in less than three hours is entirely possible.

At Atlas Steels Limited, it was necessary to locate the machine in close quarters among three existing buildings. The operating floor 31 ft above ground level. The ladle used has 35-ton capacity arranged for lip pouring. It has a refractory-lined steel cover. After ladle inspection, the slag dam and spout for the lip pouring operation are prepared. The shell is lined with 4½ in. of insulating brick upon which standard ladle brick is laid. The slag dam and spout are so constructed that the metal is underpoured and thus any slag on top

Figure 1 — The continuous casting machine at Atlas Steels has four levels.

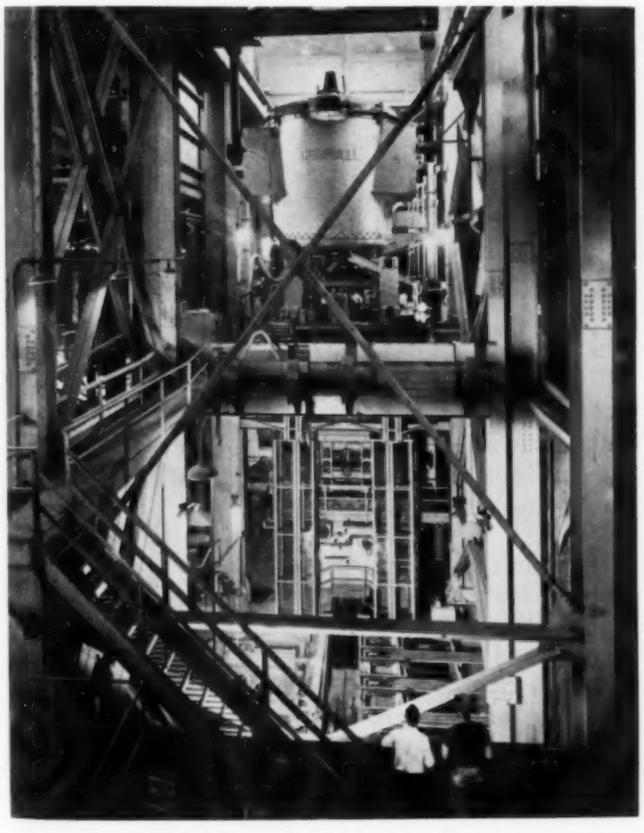


Figure 2 — A simple slag dam is built into the pouring spout to prevent passage of slag from ladle to tundish.

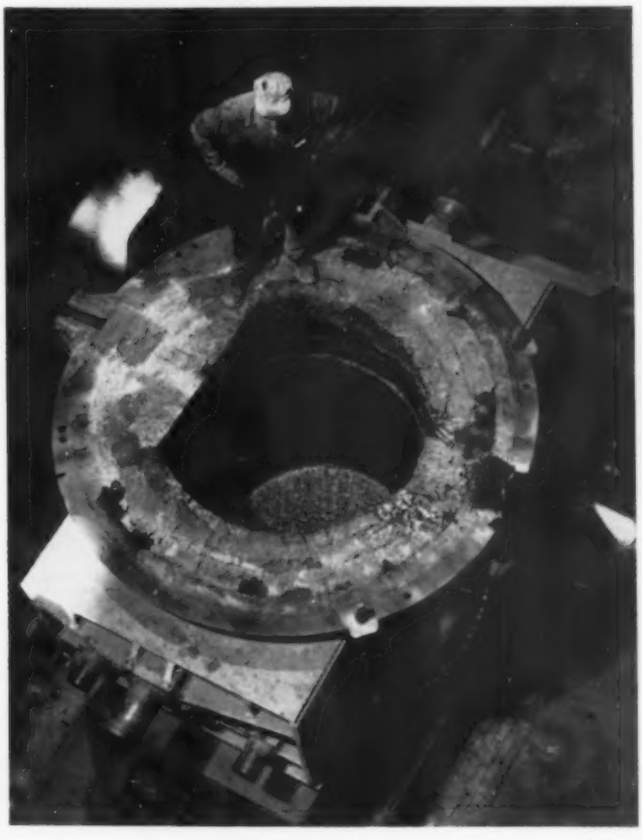


Figure 3 — Tundish is heated to 2400 F before pouring starts.

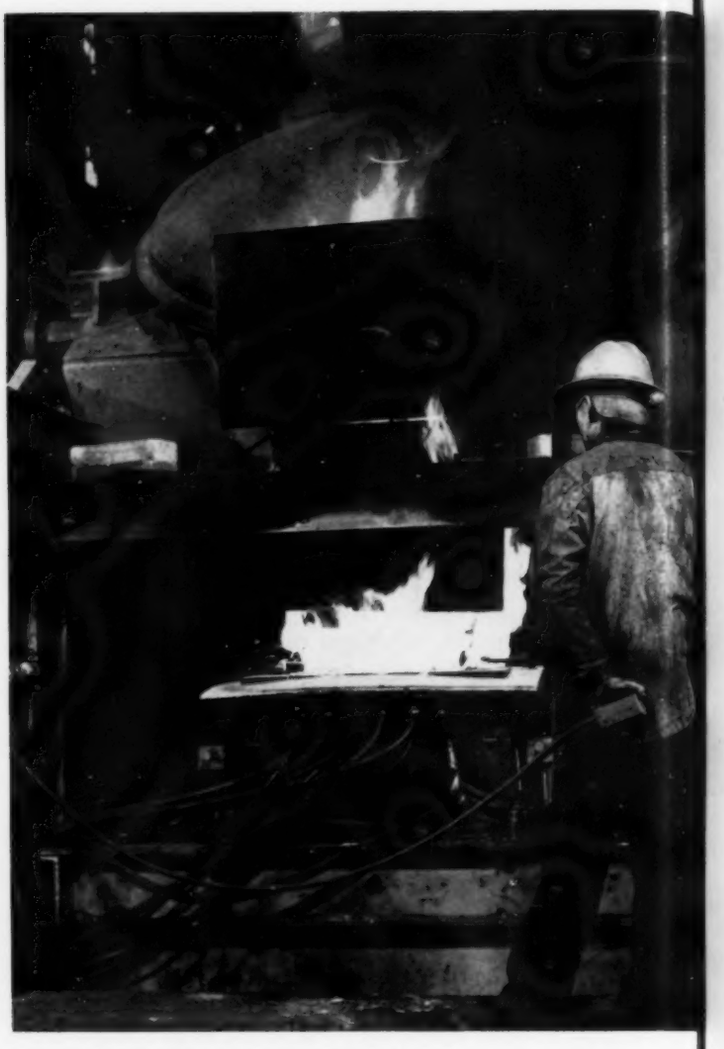


Figure 4 — Machine speed is regulated by operators according to the level of the metal in the mold.

of the metal is prevented from flowing into the tundish. High ladle-lining temperatures are required.

First step in setting up the machine for a cast is the inspection and the mounting of the roller-apron and cooling sprays in the enclosed, ventilated spray-chamber. The spray system is constructed to permit great latitude in cooling rates. A large number of small sprays are arranged in vertical headers with provision for varying water pressure in the whole or in any part of the system. These sprays are fitted with replaceable nozzle tips. Larger or smaller-size tips can be quickly exchanged to obtain any desired spray pattern.

The rapidity of final solidification is dependent upon grade of steel cast, speed of the machine, and the amount and application of coolant.

The spraying operation is more effective when the water can be applied at pressures above 30 psi, and preferably in the range of 50 to 75 psi.

The cooling area, or in other words, the area from below the mold to the lower set of pinch rolls, is the most critical area in the casting operation. Here the steel is made good or ruined. Much attention is given to the spray-patterns and to working out the proper patterns for various sizes, grades of steel and casting speeds.

The roller-apron is an integral part of the spray system. It consists of a series of small rolls rigidly placed one above the other. It is mounted as closely as possible to the bottom of the mold. The nozzles, located between rolls, spray water against the hot casting. Thus the rolls are kept cool and assist in the cooling of the casting.

In addition to the cooling effect, the roller-apron keeps the casting dimensionally true, preventing twisting and bulging of the casting during the critical period when the shell is thickening and the center is either still molten or in a plastic state.

The next steps in preparation are the setting of the mold into position, the lowering of the starting bar into the mold, and the clamping of the bar in the pinch rolls so that the head of the bar is located just within the bottom of the mold. The space between the starting bar and the mold sides is then packed with asbestos rope. Bolts have been placed in the head of the starting bar. Around these bolts the first metal freezes and unites the cast with the starting bar.

The mold made from a solid block of the purest copper has a vertical length of approximately twenty in. The inner surface is plated with chromium for resistance to wear. The mold has a series of water-cooling

passages running parallel to and surrounding the mold opening. Restrictor rods are inserted so that the water traveling around each at high velocity provides maximum heat transfer at the surface of the passage.

One purpose of the mold is to shape the casting. Depending on machine speed and metal temperature, thickness of the steel shell formed in the mold will vary between ⅛ and ½ in. The main portion of this shell is formed in the top 2 to 4 in. of the mold, where contact between casting and mold is most intimate. Below this top area, the casting shrinks away from the mold sharply, reducing the rate of heat transfer and solidification. It is therefore desirable to keep the mold as short as possible in order to spray-cool as quickly as feasible.

Next, the tundish is set above the mold. The purpose of the tundish is to deliver to the mold the required amount of slag-free metal in a low velocity, low turbulence, precisely positioned vertical stream.

The turbulent metal from the ladle pours into the back chamber of the tundish. The first dam holds back any slag or gangue which might flow into the tundish which has been preheated with a small gas burner to high temperature, generally to 2400 F. Radiation pyrometer temperature checks are periodically taken.

The main machinery drive is located on the level beneath the spray floor. Here also are the pinch rolls and the mold oscillation cams. The starting bar is clamped in the pinch rolls, which are set at a predetermined pressure. Mold oscillation is through a cam and lever system, driven from the main drive and synchronized with pinch roll movement. Down to and including this level, all operations are controlled from the operating floor.

Below the machinery floor at ground level is the cutting chamber. The entire operation of cutting and discharging the billet is automatically controlled through an electrical control panel. In the ventilated cutting chamber is the torch-carriage suspended from four chains.

In actual operation, the torch-carriage clamps itself to the slab when the desired length has been reached. The torches then go through their starting and cutting cycles, while traveling downward with the casting. After completing the cut, the torches extinguish themselves and return to their starting position while the carriage releases itself from the casting and raises to starting position preparatory to the next cut. For wide sections, two cutting torches are used. The two torches cut simultaneously from each side with the first torch moving out of the way after completing its portion of the cut while the second torch finishes the cut-off.

During the cutting operation, the casting enters the discharge pit through a funnel where it is received on the lowering bracket. After the completion of the cut, the bracket lowers the casting into the pit and transfers it to the billet carriage which in turn raises the casting to floor level. A drag chain conveyor transfers the slab across a cooling bed and into a cradle.

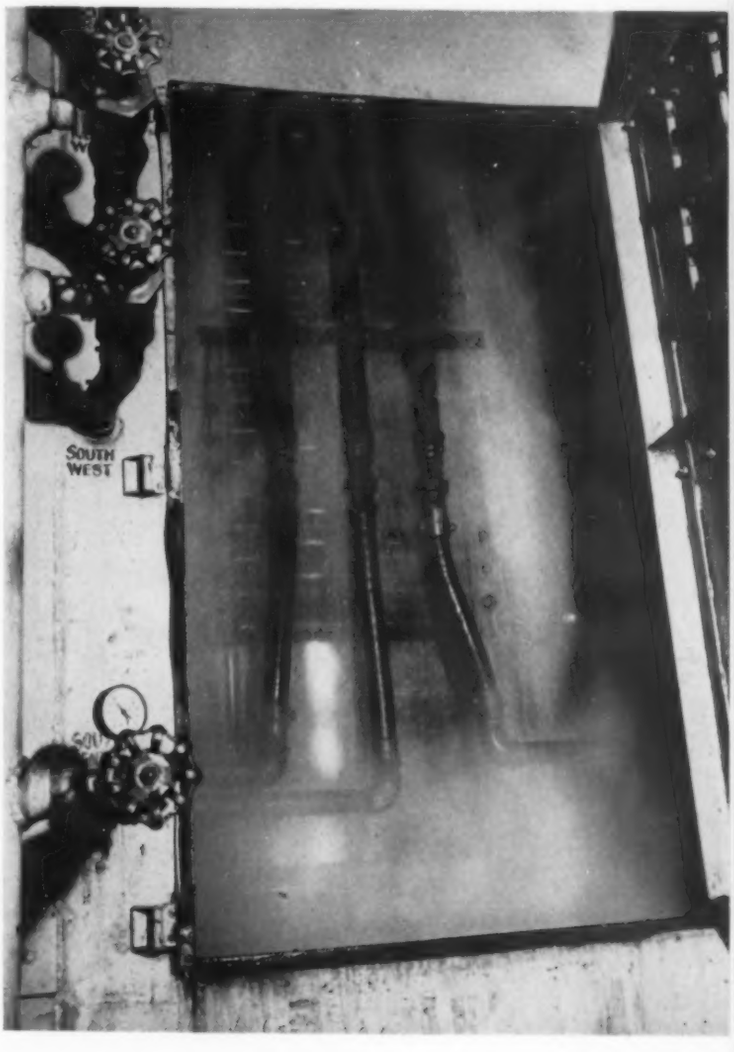
Instruments record or indicate temperatures of molten metal, cast surfaces from mold to the cut-off, water to and from mold and sprays. Other instruments record or indicate flow and pressure of water to and from mold and sprays and motor amperage. All are integral parts of the operation.

A large dial-type indicator gives machine-speed. A gamma ray control instrument gives constant indication of metal level in the mold. It is used to control the machine speed, the rate of flow of metal from the tundish, or both.

Let us now follow the actual casting of a heat. When the signal is given that the furnace is ready to tap, the lid of the preheated ladle is removed and the ladle is carried to tapping position at the furnace. A steel ring filled with refractory is placed over the ladle rim to protect it from splashing while the heat is being tapped. During tapping, slag in the ladle should not be allowed to exceed one in. After completion of the tap, the ladle is set on the transfer car and the lid fastened to it.

In this installation it was necessary to put the continuous casting machine some distance away from the melt shop. The ladle must be transferred from the furnace building, through the stripping building, over a turntable, into the continuous casting building where it is picked up by an overhead crane and taken to the tilting cradle on the operating floor of the casting machine.

Figure 5 — Water is sprayed on the casting to remove heat, primarily to complete solidification before casting reaches the cut-off level.



After the ladle is set in the tilting cradle, a high-velocity oil burner is attached to an opening in the ladle cover, close to the pouring spout. The purpose of this burner is to compensate for heat loss, to hold back slag, to stir the metal and to prevent oxidation and alloy loss.

Before proceeding with the casting, a temperature reading of the metal is taken with an immersion thermocouple. Then the ladle-spout, ladle-cover and tundish are given a final cleaning. Additional propane manifolds are attached and the protective atmosphere established.

The ladle is then gradually tilted. The initial small flush of slag is diverted into a separate container and the flow of clean metal into the tundish begins. Mold-water and mold-lubrication are now turned on. As soon as metal flowing into the mold has reached a level of 3 to 4 in. below the top of the mold, the machine is started. Machine speed is regulated by the operator, according to the metal level in the mold which should be held 2 to 4 in. below the top edge with the least possible variation in machine speed. A steady rate of flow from the tundish to the mold is effected by holding the head of metal in the tundish constant.

Installation of the gamma-ray and auxiliary equipment will give completely automatic regulation of metal flow and control of metal level in the mold and tundish.

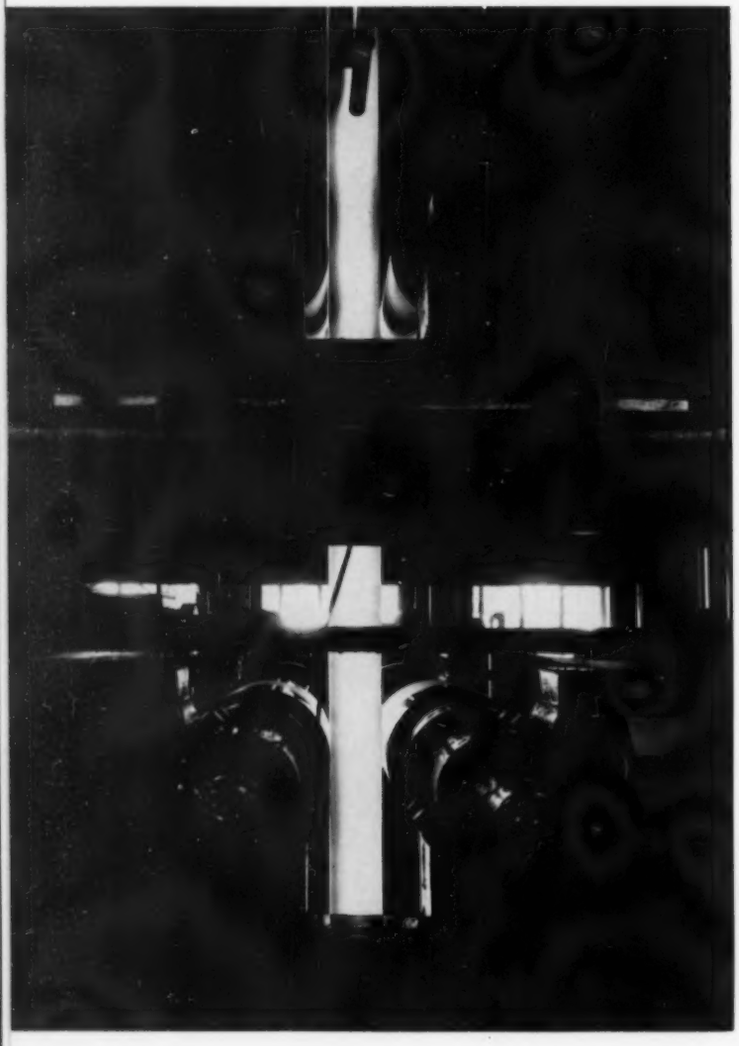


Figure 6 — Pinch rolls below operators chamber support casting.

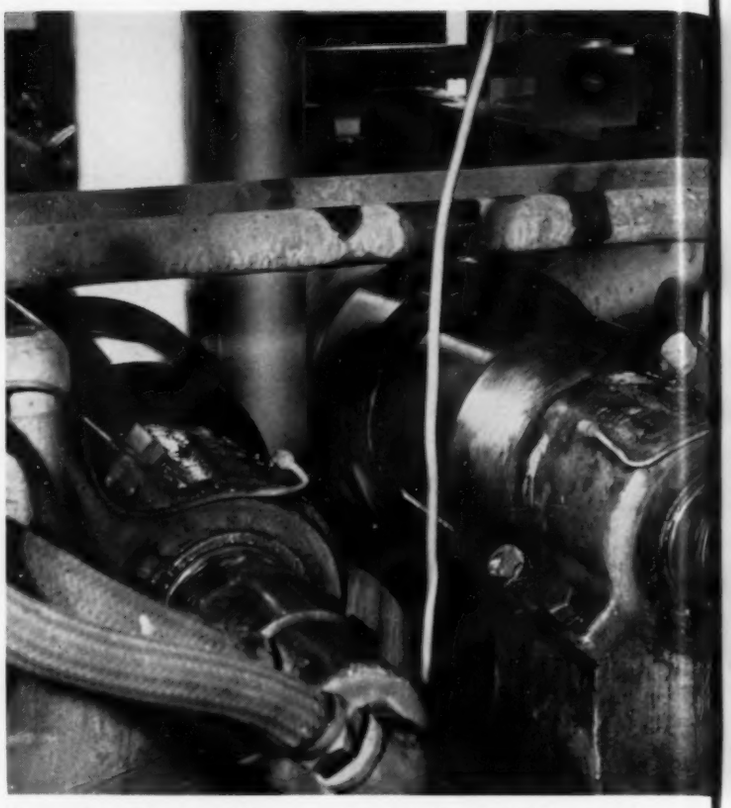


Figure 7 — Pinch rolls are actuated by variable speed drives synchronized with the mill oscillation.

As the operation begins, the starting bar moves downward, bringing the newly formed slab out of the bottom of the mold and into the spray system.

The casting emerging below the spray-chamber normally has a temperature between 1800 and 1900 F. By carrying the casting-temperature in this area well above the critical, stresses which are set up during rapid quenching are relieved.

From below the spray-chamber until the casting reaches the cutting-chamber, complete solidification and equalization of the temperature over the entire cross-section of the casting takes place. Radiation pyrometers are mounted below the spray-chamber and in the top of the cutting-chamber to give continuous temperature readings of the casting.

Below the lower set of pinch rolls, the casting enters the ventilated cutting-chamber and is guided through the torch-carriage.

The first cut is then made immediately above the top of the second half of the starting-bar. The cutting and discharge equipment is then set on automatic cycle. As the proper length of casting is reached, a limit-switch functions, causing the torch-carriage to clamp itself to the bar. The torches then automatically go through their lighting and cutting cycle, following the casting as it continues in its downward movement. Upon completion of the cut, the casting falls away and is lowered into the discharge-pit on a bracket. The torch-carriage then unclamps from the casting and returns to its upper position, while the torches return to their starting position.

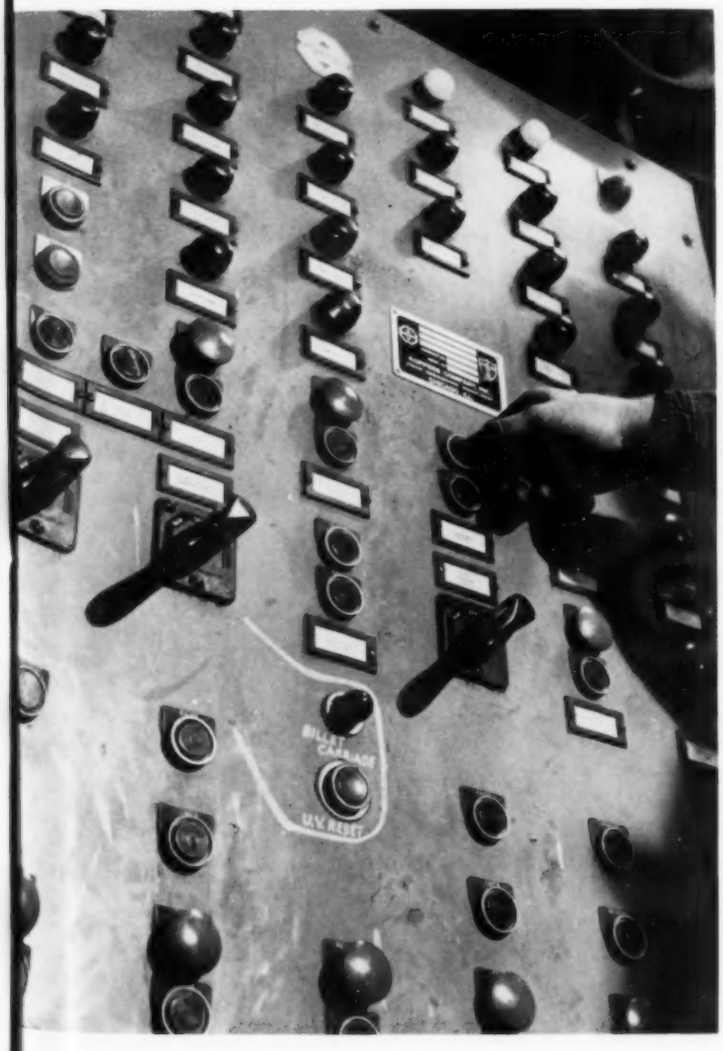
As soon as the slab has been lowered into the pit on

the lowering-bracket, it is deposited on the billet-car which automatically moves out and up until it is in a horizontal position opposite the cooling-bed. The pusher then shoves the casting onto the cooling-bed. When the pusher has returned to its starting point, the car lowers itself into receiving position in the pit and a drag-chain conveyor hauls the casting across the cooling-table and deposits it into a cradle. From here the casting is taken, weighed and stocked or charged into the soaking pits.

Summarizing, the various stages of the Atlas operation, it is appropriate to point out that continuous casting is obviously no longer a figment in the imaginative minds of steel men. It is a ready, versatile tool awaiting application in old plants and new where modern methods are being studied to effect economies. It is not difficult, but completely feasible, to cast the large slabs now being made by conventional means for large strip mills. Actually certain problems common to the casting of small shapes are minimized in pouring larger sections.

In contrast to the slab operation described, the process is readily adaptable to the casting of shapes down to two in. square. To meet the problem of metal

Figure 8 — Entire operation of cutting and discharging billet is automatically controlled through an electrically controlled panel.



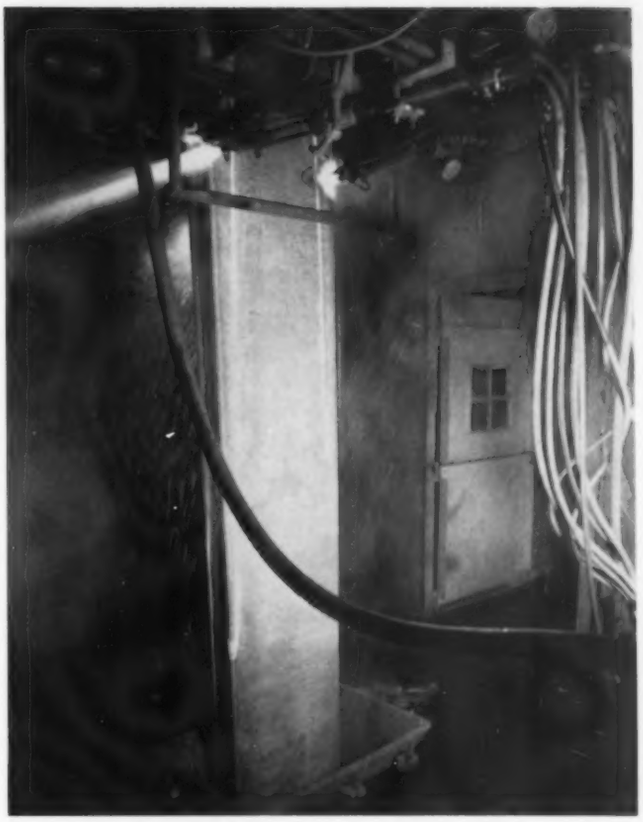


Figure 9 — For wide sections, two torches are used for cutting.

disposal, machines to cast small sections are designed for simultaneous casting of two or more strands.

The guiding principle of practical exponents of continuous casting is to provide the casting facilities to consume the contents of the *melt* furnace in one cast, without benefit of holding furnaces or other expensive auxiliary equipment.

Let us say in conclusion that development of the equipment and the art of casting since the installation of this machine, has been made possible by the finest type of cooperation between the management of the operator and builder of this equipment.

It is such cooperation between the producers of steel and the designers and builders of steel mill equipment that makes for real progress within the industry.

APPENDIX

Some of the details which individually and collectively determine the successful operation of the continuous casting machine are given in this appendix.

Casting—A sample etched section of stainless 304 is shown in Figure 12.

Ladle—The ladle suitable for continuous casting (Figure 13) differs little physically from conventional ladles except in the following respects:

1. Insulated.
2. Larger correspondingly.
3. Lip pouring.
4. Covered.
5. Slag dam.

The ladle must be well heated to insure that it is dry and hot enough to hold the tap without abnormal loss

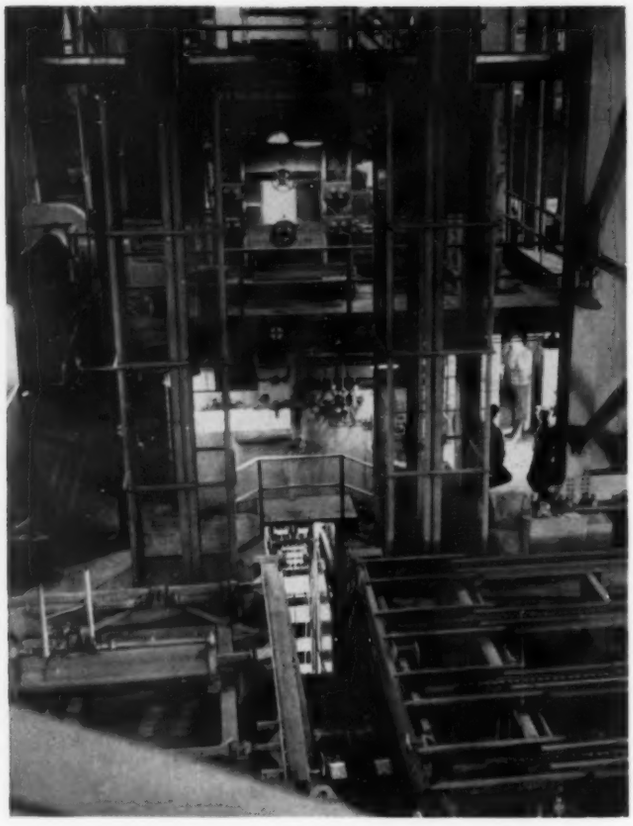


Figure 10 — Discharge pit can be seen through opening in slab transfer.

Figure 11 — Carrier is emerging on ground floor level from pit with a finished slab and being placed on transfer table.

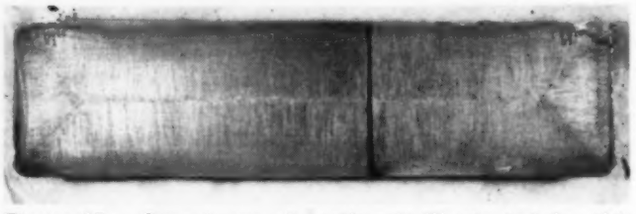


Figure 12 — Soundness of casting is illustrated in this cross-section.

of temperature. The heating is done by a single high-velocity oil burner to approximately 2400 F. The heating flame may be oxidizing. Twenty to thirty gallons of oil per hour is sufficient. After the tapping, the cover is replaced and the ladle delivered to the tilting cradle at the pouring level of the machine. Here, another high-velocity burner is attached to hold the molten metal at temperature. This burner will consume 30 to 34 gphr. In this instance a reducing flame is used. If this flame is not reducing, the steel will be oxidized and soon cause trouble at the ladle pouring spout and in the tundish nozzle. The average heat loss while holding during the pour is less than one degree per minute. There have been instances where no drop in temperature occurred during the entire pour. As little as 100-lb skulls have been removed after pouring from the 35-ton ladle.

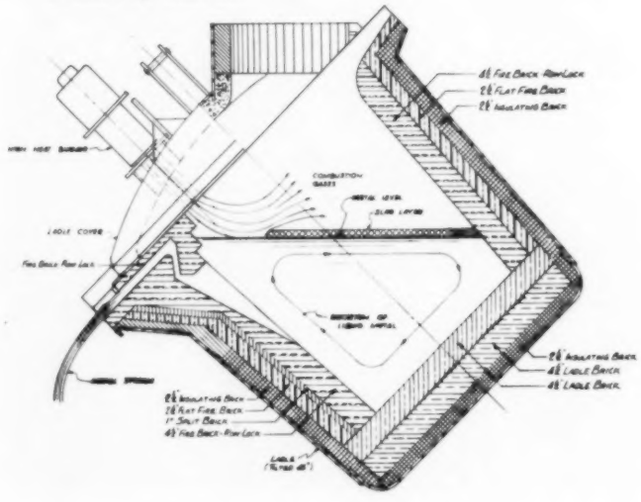
Tapping temperatures at the melt furnace vary according to grade. The average range is between 2800 and 3000 F. The steel temperature in the ladle after delivery to the top of the casting machine is checked with an immersion couple and will vary according to grade between 2750 and 2850 F. Periodic optical checks are made of molten metal temperature from ladle spout.

Very slight metallurgical change occurs during the pour. For example, checks of silicon content at both ends of a pour reveal no significant loss. This has been attributed to the paucity of slag, the reducing atmosphere, and stirring action of the flame directed against the metal surface.

A simple slag dam is built into the pouring spout to prevent the passage of slag from ladle to tundish. The stream of molten metal from the ladle is enveloped in an atmosphere of propane which deters the formation of troublesome oxide in the ladle spout and tundish.

Tundish—The tundish (Figure 14), a steel box lined with 2½ in. of insulating brick over which is laid ordi-

Figure 13 — Cross-section through ladle shows rotation caused by burner.



nary ladle or basic brick, is provided with underflow and overflow dams which serve to skim non-metallic matter and to assure a tranquil pool of metal above the nozzle in the forward chamber. The absence of turbulence contributes largely to a well directed and quiescent stream of metal from tundish to mold. The nozzle is made of stabilized zirconia. The tundish is heated to 2400 F before start of pour.

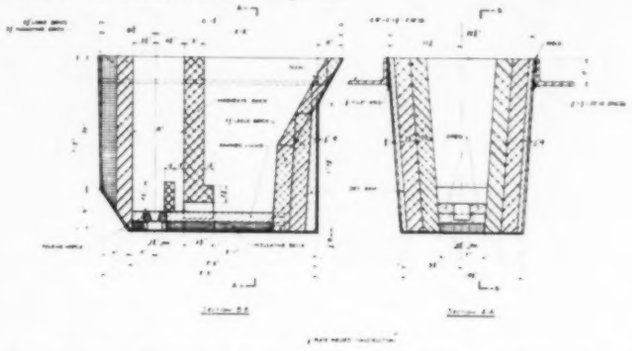


Figure 14 — Section through single hole tundish shows one pouring nozzle used.

Nozzles—An interesting side light, are the tests which have been made to find a nozzle with shape and flow characteristics satisfying the requirement for a good stream of metal. Ideas on this subject appear to vary widely. Little could be found in the way of pertinent information on this subject.

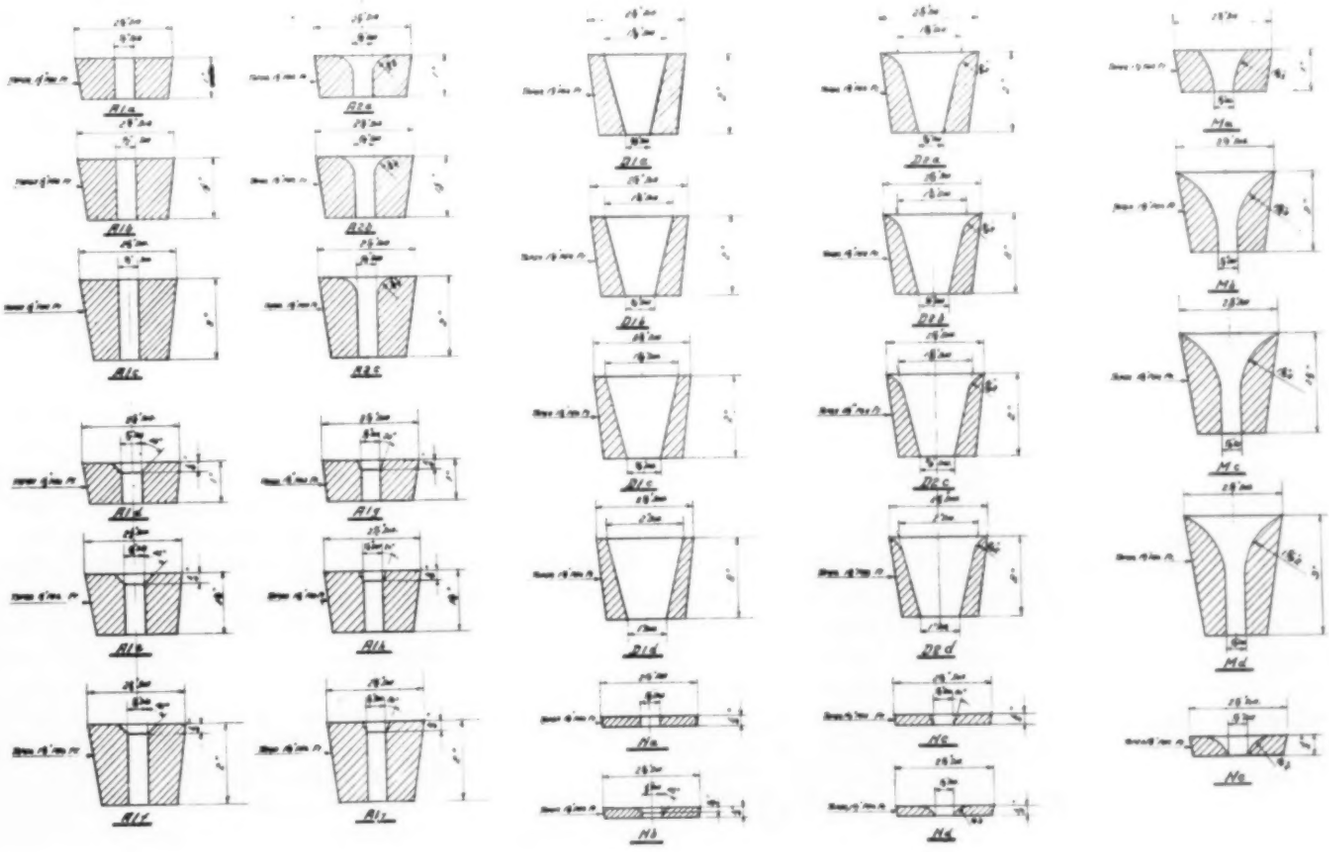
Over 700 tests were made and over 400 photos taken to settle this question once and for all. Figure 15 shows some of the numerous nozzle shapes which were tried. Plastic nozzles were made in all of these shapes. A glass tundish of suitable dimensions was constructed. Water was used to simulate molten steel. The fluidities of molten steel and water are very similar, though of course, their relative densities vary greatly. Flows were observed at 10-in. head and 20-in. head. Flow to tundish was carefully controlled and metered. Flow streams were photographed. Since the casting surface and quality are adversely affected by a bad stream and the turbulence of the metal surface in the mold, it is obvious that a quiet even flow is a real factor.

To eliminate guesswork, a chart was prepared to assist the operator in selecting a nozzle size for a suitable head or casting speed for each size casting. The chart also indicates the casting rate in pounds per minute. See Figure 16.

Mold—The mold consists of a solid casting of pure or electrolytic tough pitch copper with vertical drilled water passages arranged around the mold cavity. These passages are fitted with restrictor rods which cause the water to move at high velocity and to scrub heat off the walls of the passage. Water consumption varies between 100 and 300 gpm. Temperature rise will vary between 10 and 30 F. Approximately 40 to 60 Btu per lb are removed from the molten metal.

Casting speeds vary widely with the size and analysis of the steel being cast. The 5½ x 21½ in. section has been cast at the rate of over 40 tons per hour. Small sections are cast at relative rates. Surface of the metal at the top of the mold is protected by an envelope of pro-

Figure 15 — A large number of nozzles were tried in the test program.



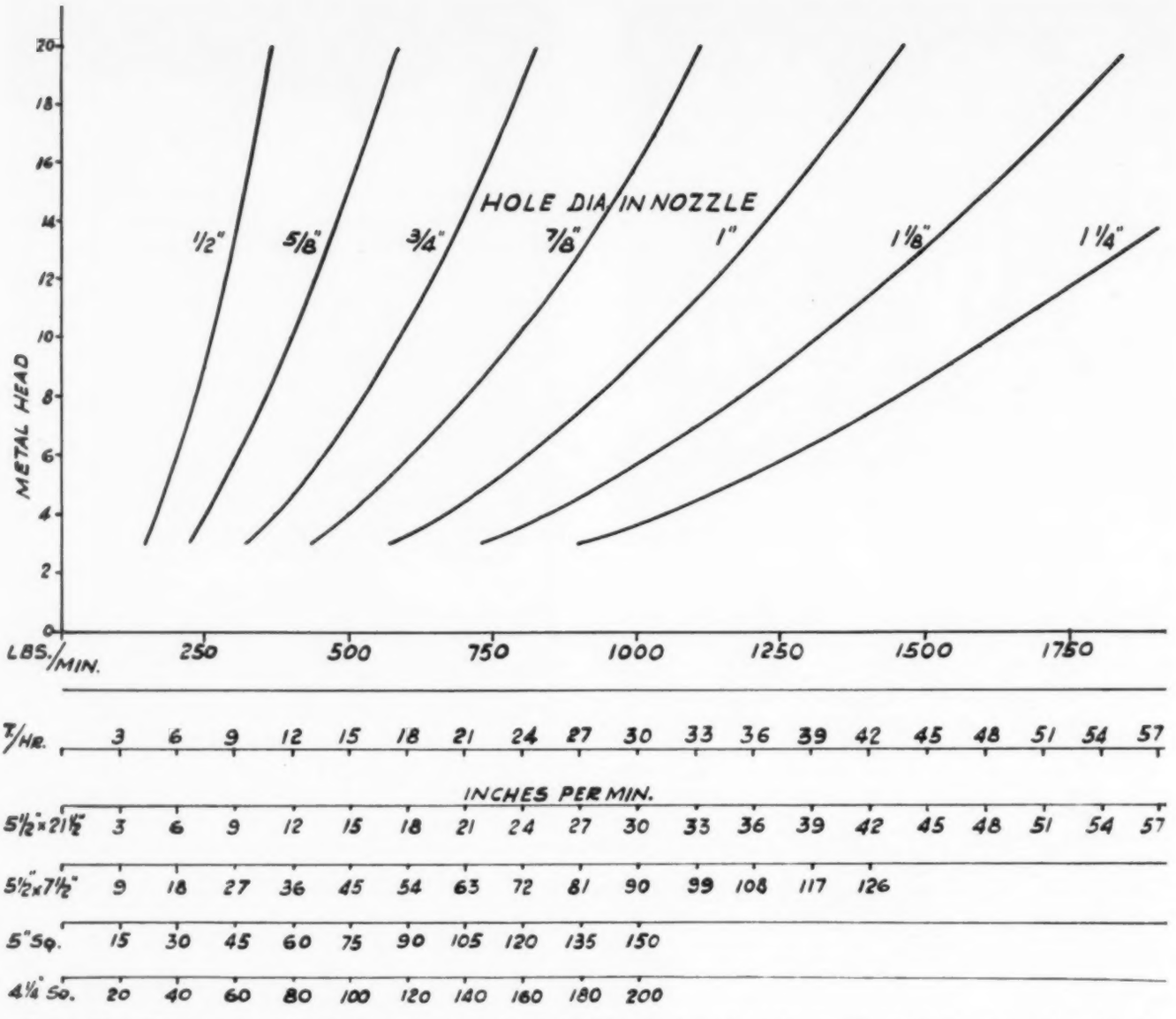


Figure 16 — This nomographic chart was prepared to help the operator select the proper nozzle size for various heads and casting speeds for each size casting.

pane gas to prevent oxidation. The mold is oscillated vertically through an amplitude of from ¾ to 1½ in. This oscillation facilitates heat removal, lubrication, and promotes good casting surface. Small quantities of rape seed oil are trickled down the inner walls of the mold.

Cooling System—The cooling system located just below the mold in a ventilated enclosure consists of a suspended roller box and sprays arranged in vertical pipes fixed to the box so that the flat spray nozzles impinge on the hot casting between the rolls. The sprays and rolls cool the casting and prevent deformation. Water consumption varies with the size of the casting, the rate of casting and the analysis of the steel being cast. It will vary between 30 and 700 gpm. The roller box and sprays may be quickly disengaged and exchanged when casting sizes are altered. Nozzle tip sizes vary with location between 0.3 gpm to 10 gpm.

It is desirable to use pressures in excess of 30 psi for efficient cooling. The temperature rise of spray water varies between 50 and 70 F.

Machine Drive—A 15-hp motor powers the withdrawing or pinch rolls through a mechanical, variable speed drive which is synchronized with the cams oscillating the mold. The pinch rolls are set to 32,000 lb on the starting or dummy bar which is slightly smaller than the casting. When the casting passes through the pinch rolls, the same setting will indicate 48,000 lb pressure. These rolls do no discernable work on the casting, but act as a controlling rolling brake.

Cutting—Oxy-acetylene torches using iron powder for fast cutting are mounted on a water-cooled carriage suspended from counterweighted chains. As the casting passes through the cutting device, a limit switch causes the carriage clamps to grasp the descending casting at a predetermined setting. The torches are lighted and the cutting cycle is underway. Upon completion, the clamp automatically releases, the torches are extinguished, and the carriage and torches return to their starting position. Approximately 2½ to 3 cu ft acetylene, 60 to 75 cu ft of oxygen and 2½ to 3 lb of iron powder are consumed per cut, using two torches

on the 5½ x 21½ in. stainless slab. Temperature of the casting at this point is between 1700 and 1800 F.

The Delivery Mechanism—After the torches finish cutting the casting, it is secured by the lowering bracket which lowers it to the bottom of the pit, 20 ft below. Here the casting is transferred to the billet car as lowering bracket and car intermesh. A limit switch is contacted by the lowering bracket at the bottom which starts the billet car out and up the track to the level of the cooling bed. As the end of the car completes its travel, another switch causes the pneumatic pusher to shove the casting on the cooling bed and the drag conveyor to operate, carrying the casting to the receiving cradle.

DISCUSSION

PRESENTED BY

EMIL KERN, Vice President in Charge of Engineering, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

RALPH D. HINDSON, Works Metallurgist, The Steel Company of Canada, Ltd., Hamilton, Ontario, Canada

JOHN F. BLACK, Manager Continuous Casting Section, Freyn Dept., Koppers Co., Inc., Pittsburgh, Pa.

T. Y. WILSON, Manager of Melting, Allegheny Ludlum Steel Corp., Watervliet, N. Y.

Emil Kern: I was wondering, do you have figures available on the yield on the slabs or ingots or billets?

Ralph D. Hindson: I wonder if Mr. Black is free to tell us what nozzle type he finally decided on to get the least amount of turbulence?

John F. Black: As with other methods of casting steel, a theoretical yield is calculated for a given section and then we strive to attain this figure while casting the section. Yield depends first on the crop necessary. With continuous casting, there is an inherent advantage in that theoretically there is only the small portion next to the dummy bar and the end bit which last leaves the mold which should be cropped. However, yield will be affected by the amount of skull left in the ladle, by the accuracy of cutting, by the accuracy of the shape cast. Everything considered, the most important yield factor is in getting the entire heat cast. It is not unreasonable to expect 95 per cent yield. As the heats and section become larger, yield percentages should normally be better.

Regarding nozzle shapes, the experience gained from our rather exhaustive tests indicate a simple shape is best. A tapered nozzle (inlet larger than outlet) similar to those in the D1 series on Figure 15 proved the best. Strange to say, the depth or height of the nozzle had little effect on the efficiency of the nozzle. A rounded approach to the nozzle increased flow slightly but did not make flow characteristics any better.

T. Y. Wilson: I might add a little bit to the question on yields. I think this is a very important thing related to continuous casting, that is, the casting, within reasonable limits, can be cut to any desired length and that length has a weight which is an even multiple of the product you want to make out of it. We had the occasion to cast 3 ¾-in. squares. For convenience we cut these into five-foot lengths. Our yields on small flats which were rolled from that particular stock were disappointing, in fact, not satisfactory at all. By a simple calculation we found that if we cut seven-foot lengths we improved our yield 12 per cent, getting our yield on that particular type (dead-length, small flats on the order of ⅛ x 1 in.) up to a little better than 85 per cent after rolling.

John F. Black: To add to the previous data on yield and illustrate the performance of, and also some of the troubles encountered in, continuous casting. Tables I and II give a summary of 24 *consecutive* heats of Type 302 and 304 stainless cast in the 21½ x 5½ in. slab mold. At about this period the torch and torch moving mechanism were completely rebuilt as well as an additional water pump installed and other miscellaneous mechanical changes made.

TABLE I

Grade cast	Type 302 and 304 stainless
Mold size	21½ x 5½ in.
No. heats	24 Consecutive
Ladle drained	19 times
Casting interrupted	5 times

Interrupted heats	Per cent of metal in ladle poured	Reason for stoppage
1	7.9	Breakout due to high metal temperature.
1	27	Torch failure.
1	48.2	Tundish nozzle failure.
1	51.3	Torch operating mechanism failure.
1	78.3	Mold overflow due to operator error.

Slag layer in ladle	1½ to 2 in.
Temperature in ladle immediately before casting (Dip thermocouple)	Average 2780 F.
Mold water used	Approximately 325 gpm.
Spray cooling water used	400 - 600 gpm dependent on speed.
Speed range (all 24 heats)	Between 25 and 50 in. per min—average 30.2 in. per min.
Casting rate	Average of 24 heats—27.6 Tons per hr.
Casting rate	Fastest heat—34.4 Tons per hr.
Nozzle sizes	¾-in. diam to 1-in. diam.
Temperature surface at bar center in cut-off chamber	1500-1650 F.
Internal quality on all heats excellent.	

TABLE II

Yields	24 Consecutive heats	19 Completed heats
1. Weight of metal in ladle, net tons	622.8	494.2
2. Weight of metal cast, net tons	540.2	485.7
3. Per cent of metal in ladle cast, Line 2 ÷ Line 1	86.7	98.4
4. Weight of metal to mills, net tons	531.1	478.6
5. Scrap—cutting loss—tests—Ladle skull—not cast metal, etc, net tons	91.7	15.6
6. Per cent scrap, Line 5 ÷ Line 1	14.6	3.16
7. Per cent metal to mills over metal in ladle, Line 4 ÷ Line 1	85.4	96.84
8. Weight after rolling to 2¼ x 17 to 20-in. slab, net tons	504.2	454.8
9. Rolling yield, per cent, Line 8 ÷ Line 4	94.8	95.0
10. Per cent weight after rolling to metal cast, Line 8 ÷ Line 2	93.2	93.5
11. Per cent weight after rolling to metal in ladle, Line 8 ÷ Line 1	80.9	92.1

Extending Blast Furnace Stack Life after Appearance of Hot Spots

By R. W. SUNDQUIST
Assistant Division Superintendent
Blast Furnaces
United States Steel Corp.
Gary, Ind.

. . . . blast furnace lining life can be extended appreciably through control of hot spots . . . . control of these spots requires detection through regular inspection, spraying, grouting, and installation of dovel plates . . . . additional life up to a year can be attained with resultant additional tonnage . . . . furnace operation is satisfactory . . . .

▲ MOST blast furnace operators undoubtedly have had to cope with a hot spot in the stack of one of his furnaces at one time or other and perhaps been forced to shut it down for relining when shell sprays failed to solve the problem. Those who experienced hot spots during periods of extremely high demand for pig iron production such as the post war years, found it virtually impossible to shut the furnace down and were constrained to seek other means of extending the lining life in those stacks. In many instances, the life of the furnace was prolonged for many months of satisfactory operation; and, in general, the methods used in combating hot spots fall within the following four point program:

1. Detection of incipient hot spots.
2. Installation of shell sprays; augmented by insertion of steam lances.
3. Pumping grout inside of the furnace shell.
4. Installation of dovel type cooling plates.

Most of us, in the past, have had some experience in the detection of hot spots, that consisted of a telephone call in the middle of the night from a foreman who said, "I just happened to look up and saw a red-hot spot on the shell——." Of course, this is an unsatisfactory method of detection, both from the standpoint of disrupting the superintendent's sleep, and from the standpoint of discovering a weak spot in the early stages of development when it might be corrected more easily. Therefore, much early thought and effort was directed toward developing point No. 1 of the program, detection of incipient hot spots.

Some paints which change color at specified temperatures have been investigated, but they seem to be too expensive for general use. Infra-red photographs of the furnace shell have been made at night and may present a possible solution, but, so far they do not seem to be sensitive enough to measure the necessary temperature differential. The contact pyrometer shows the most promise of becoming the answer to the detection problem and it has been used during some extensive surveys of furnace shell temperatures. A great deal of time has been spent taking and recording hundreds, yes thousands of temperatures, noting ambient temperatures and weather conditions as well. The surveys disclosed some unexpectedly high temperature differentials within relatively small areas which, coupled with an analysis of data gathered on actual hot spots, revealed that initially the trouble most often developed in a band approximately 10 to 15 ft high and 20 to 35 ft above the mantle. This area is readily accessible from existing walkways on most modern blast furnaces so that a routine weekly check of shell temper-

atures with the contact pyrometer may be established. (Note: Our safety rules require the wearing of gas masks when working on the furnace shell with the blast on.)

The data indicated that normal shell temperatures ranged between 100–150 F, and that temperatures falling within the 200–300 F range pointed to a deterioration of the lining, therefore, when temperatures are found in these upper ranges, more frequent readings should be taken, even to the extent of daily checks. In addition, everyone connected with the operation of that furnace can then be alerted as to its condition so that any change may be noted without delay. When temperatures exceed 300 F or have shown a consistent upward trend, a stop on the furnace is necessary to determine the actual condition of the lining. This is done as follows: At the center of the hottest area, a hole is burned in the shell and the remaining thickness of the lining is determined by diamond core-drilling. Core-drilling usually confirmed the loss of lining predicted by the rising temperatures, however, the rare exception again proves the rule. As a consequence of this correlation, it is evident that the weekly recording of shell temperatures with the contact pyrometer is well worth the effort, and will permit the application of preventative and restorative measures much earlier.

Having a reliable detection procedure the next requirement is to heal the spots when located, preferably before the lining is entirely lost. Points No. 2 and No. 3 of the program are basically designed to accomplish this result.

After core-drilling and the substantiation of a loss of lining, a nipple is welded over the test hole and capped. Where the remaining lining thickness is not critical, the first step then taken is the installation of shell sprays to cool the area. These sprays usually consist of sections of 1¼ in. pipe bent to fit the shell contour with ⅛ in. holes drilled every 6 in. at approximately 45 degrees from horizontal. They are positioned 15 to 20 ft above the warm spot, and enough sections are turned on to blanket a considerable area on both sides of the hot spot with water. The sprays are never made up to extend farther than 90 degrees around the furnace. If wider areas are to be cooled, additional sections, with individual feeds are installed. The sprays alone are often effective in cooling the area sufficiently to maintain the lining. The cooling of the shell, in any case, prevents the shell from becoming hot enough to buckle and fail.

In cases with only 6 to 8 in. of brick remaining, the sprays can be augmented by the insertion of a steam lining. The lance is a ⅜ in. pipe connected to a 100-psi lance through the nipple and the core-drill hole in the steam line by hose with the steam valve open one turn. The flow of steam into the furnace at the weak spot promotes a buildup of burden materials on the cooled lining, thus forming a healing scab. In some cases, especially when the warm spot covers a relatively large area, two or three tuyeres may be plugged.

The steam lance is used (in conjunction with the sprays) for several days until the shell temperatures drop below the critical point or until it is decided that further steps must be taken to contain or repair the hot spot. During the period the sprays and steam are used, shell temperature checks are made frequently. It is necessary to turn off both the water and steam when taking these readings, and the usual practice is to shut them off for 45 minutes to one hour before taking the temperatures. In this connection it is very helpful to observe the drying of the shell immediately after the water is turned off, for the hottest areas will dry quickest and often it is possible to see whether the hot area has spread or changed location.

Several incipient hot spots have been successfully contained by the above methods alone, some of which require no furter attention, except for continuing the shell sprays and temperature checks.

A typical example of rising shell temperatures, core-drilling and the use of sprays and steam lance with a resultant lowering of shell temperature is shown on Table I.

The third step of the program is the out-growth of the desire to deal with specific conditions seen through the test holes and disclosed by core-drillings which the previous steps were not effective in controlling. These conditions are; loss of packing material between the furnace shell and brickwork, cracks in the lining, and extremely thin brickwork. The grouting is intended to replace the lost packing, to fill the crack, or to provide a protective coating for the remaining brick, and the grout is pumped into the area through nipples welded over the core-drilled holes or over other test holes burned in the shell.

Initially the grout was hand mixed in a large rectangular wooden box placed on the cast house floor and connected to the suction end of an air operated reciprocating pump. With the blast off the furnace, the grout was pumped through a water hose connected to the nipples. These early attempts were not too successful as the grout evidently was being forced into the

TABLE I

Portion of Furnace "C" — Shell Temperature Record

Selected dates	Shell temp, F	Atmos temp, F	Wind - mphr	Remarks
10-23-53	150	60	N—15	Normal.
11-23-53	240	58	NW—18	Warm spot — over No. 11 tuyere on first walkway.
12- 3-53	300	53	SW—35	Same spot — 18-in. diameter.
12- 4-53	350	48	N—22	Core-drilled — 4-in. brick found — installed sprays and steam lance.
12- 8-53	280	52	SW— 8	Temperature dropping.
12-13-53	200	50	W—22	Healing — steam lance removed.
12-18-53	180	49	N—15	Holding level — continue sprays.

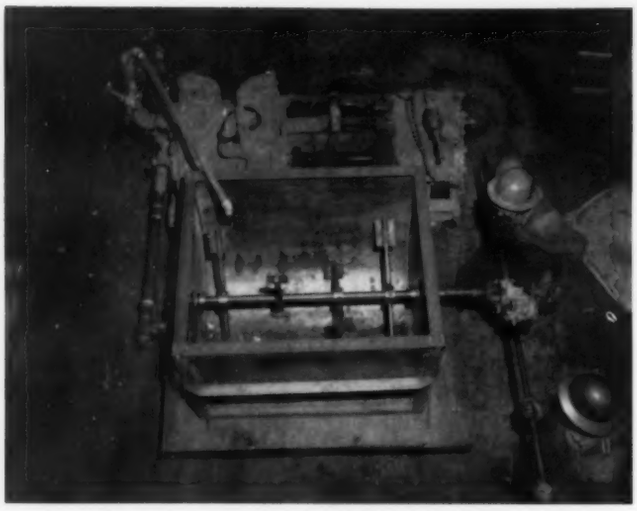


Figure 1 — Equipment shown has given improved results in grouting furnace.

burden and not remaining in the area which it was intended to protect. When attempting to replace missing packing behind thin brickwork, there were indications of a tendency to force the brick away from the shell, causing more damage to the lining. Occasional shots within the furnace were also experienced after resuming operation.

These objections have been overcome by keeping the blast on the furnace while grouting and by installing a gage and by-pass valve on the feed line so the grout pressure can be controlled. Normally, when trying to rectify the above-mentioned conditions 40-psi pressure is used; however, 80-psi pressures are used when grouting an open area where there is no danger of causing additional damage to the existing lining.

The operation of grouting the furnace has been modified to provide easier handling and better results. The mixing is now done in a 4 by 3 by 5 ft round bottom metal box, equipped with mixing paddles operated by the compressed air motor used for drilling out the tap hole. The pump is a compressed air operated, double-acting reciprocating pump with a 12-in. stroke and a 8-in. bore specifically designed to handle this type of material. The box and pump are mounted on a railroad push car. Figure 1 is a view of such equipment showing the air motor engaged to the paddle shaft.

Air-setting, highly refractory cement is now used instead of the original fire-clay grout. The blast is always kept on the furnace during grouting, and the pressure is controlled between 40 and 80 psi by recirculating the excess back to the mixing box. Sufficient holes are burned in the furnace shell and 1¼ in. by 6 in. nipples equipped with stop cocks or valves are welded over the holes which are spaced to provide maximum coverage of the affected area. A batch of grout (consisting of ten to thirteen 100-lb drums of cement thinned with sufficient water to obtain a good pumping consistency) is pumped into each nipple. This is repeated until no more grout can be forced in or until the shell temperatures indicate the condition has been arrested.

Pumping grout into the furnace has successfully retarded hot spots, especially when due to such conditions as missing packing or cracked brickwork. The best evidence of this is the following partial case histories:

Furnace "D" 10-14-51 Hot spot discovered—temperature 320 F—examination showed cracked brickwork—grout pumped and shell sprays installed.

10-10-52 Hot spot discovered farther to east—temperature 400 F—brick missing.

Furnace "E" 12-15-50 Hot spot located on north side—temperature 350 F—packing missing and crack in brickwork seen—grouted and sprays installed.

1-15-51 Hot area located on northeast side—temperature 400 F—packing missing—grouted again.

6-29-51 Areas appeared unduly warm—300 F—more grout pumped in.

10-20-51 Large hot spot found on east side — no brick — temperature 450 F.

When an investigation of a hot spot discloses that the original lining has completely disappeared and hot stock is against the shell, or when the corrective measures previously described have failed, the fourth step of the program; the installation of dovel type cooling plates, is indicated.

Prior to the actual installation, it is first necessary

Figure 2 — Typical cooling plates are short.

Figure 3 — For installation of cooling plates, holes are burned in the shell as outlined by a template.

Figure 4 — When shell plate is removed, stock must be taken out to provide space for cooling plate.

Figure 5 — Plate holder is tack welded into position.

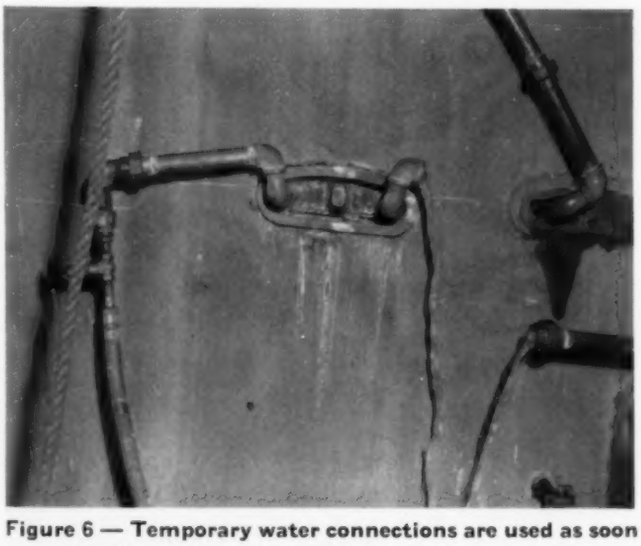


Figure 6 — Temporary water connections are used as soon as cooling plate is installed.

to determine the extent of the hot spot and outline the area in which the lining must be replaced or reinforced. The first approximation of the outline is made, before taking the blast off, by means of contact pyrometer readings adjacent to and encircling the hottest point which may show a discoloration of the shell if due to a sudden failure. These temperatures serve as a guide to locate the initial test holes to be burned in the shell after taking the furnace off blast. By probing through the holes, the condition of the brickwork can be determined, and, additional test holes are opened on an expanding radius until firm brick is located.

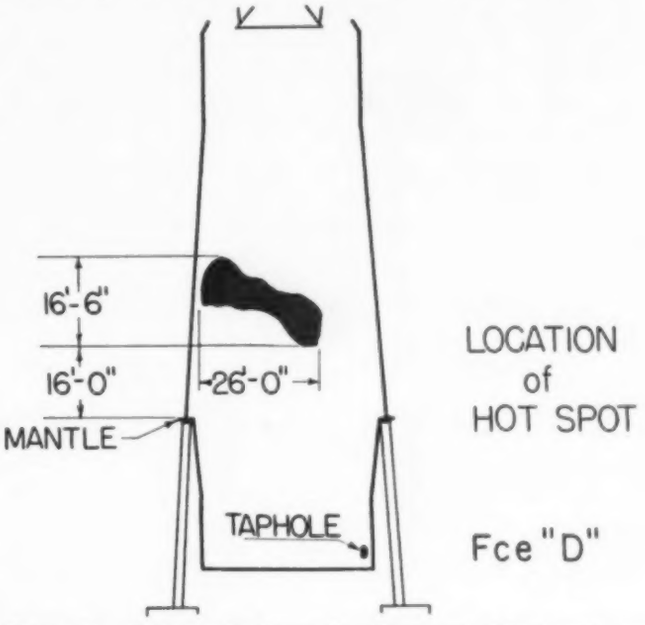
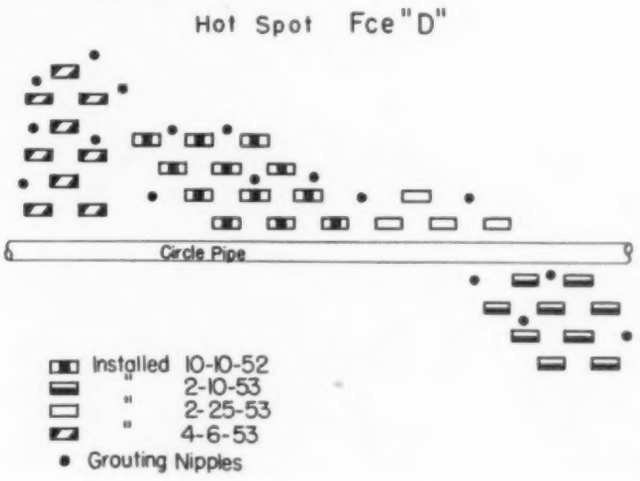


Figure 7 — Schematic shows development of hot spot on furnace "D."

The cooling plates are short, the dimensions being 13 in. wide, 3 to 14 in. thick and 10 in. long, however, some 14 or 15 in. long plates are occasionally used. Figure 2 is a photograph of a typical cooling plate. They are installed in rows spaced with approximately 27-in. centers horizontally and 18-in. centers vertically, with alternate rows staggered. The outer plates, especially the upper row, must be located against or as close as possible to undisturbed brick, thus providing support for the existent good brick and minimizing the possibility of future expansion of the hot spot.

After the area to be protected has been defined and the general arrangement of the plates to be installed has been settled, holes for the plates are burned in the shell to match a template, as illustrated in Figure 3.

Figure 8 — Sketch shows arrangement of dovel plates for hot spot on furnace "D."



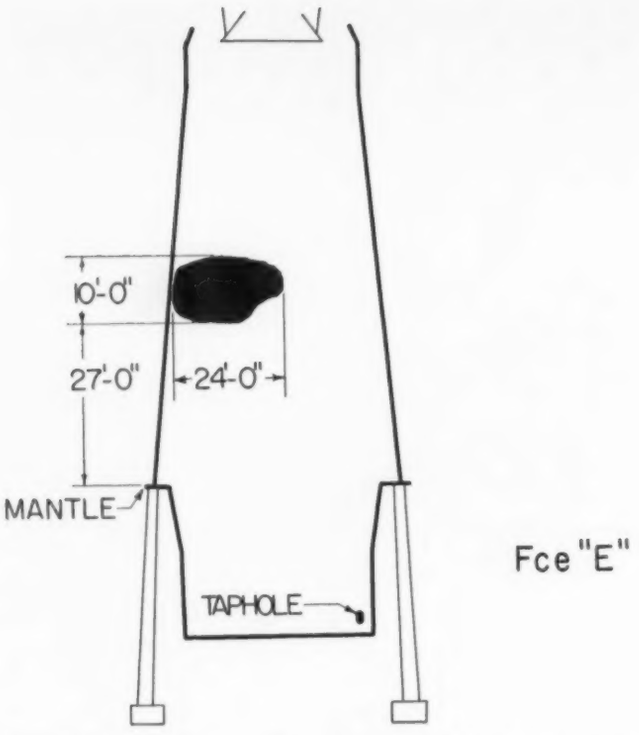


Figure 9 — Sketch shows location of hot spot on furnace "E."

Use of this template insures a tight fit for the plate holder and minimizes the amount of welding required. After the piece of shell plate has been removed, the stock must be dug out to provide spaces for inserting the plate and its cast-steel holder, as shown in Figure 4.

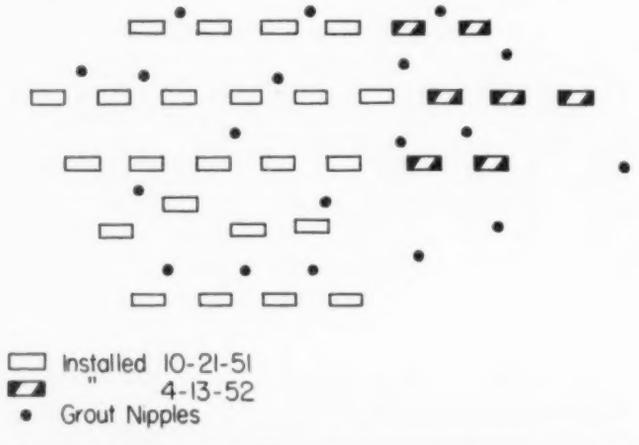


Figure 10 — Sketch shows arrangement of dovel plates for hot spot on furnace "E."

It may be necessary, if the stock is loose, to use clay to retain the cavity. The plate holder is then placed in the opening and tack-welded securely in position, as in Figure 5.

Next, the copper cooling plate is driven in to make the tightest possible fit in the holder. (As a safety measure it is advisable to have only one hole open in the shell at a time.) A temporary water connection is made immediately, as seen in Figure 6, until the permanent feed and discharge lines can be fitted, hooking a number of plates up in series.

The welders follow up to complete the welding of the holders solidly in place, adding a piece of metal to act as a stop to prevent the plates from kicking out. The completed installation at the right in Figure 6 shows the clay packing used to prevent gas leakage around the plates.

Before the furnace resumes operation, shell sprays, if not previously installed, are set up to provide a flow of water over the plate protected area as well as gen-

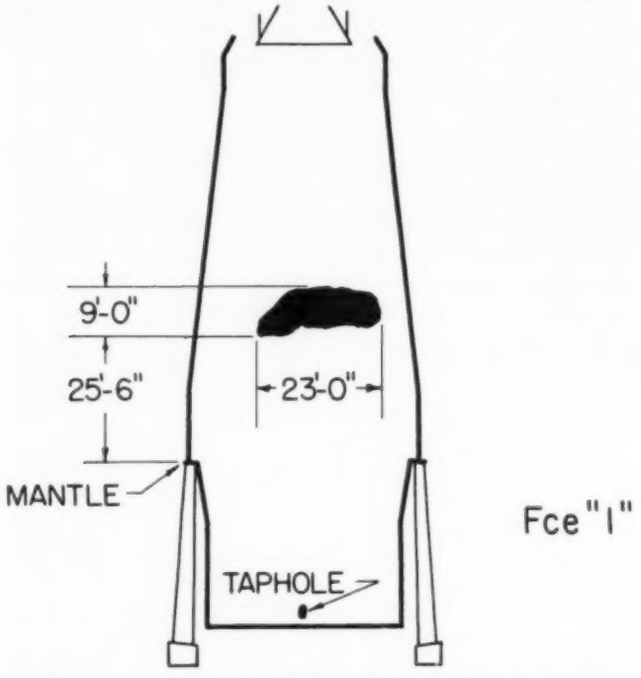
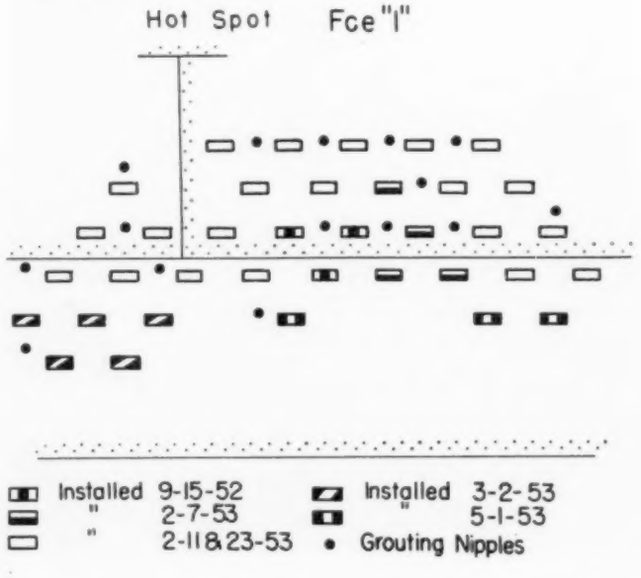


Figure 11 — Sketch shows location of hot spot on furnace "I."

erous sections of shell above and to either side of it. At the same time, grouting nipples are installed throughout the affected area at strategic points calculated to promote maximum buildup on and between the plates. Most of these will be on test holes made earlier; test holes not so used are closed with patches. After the blast is back on the furnace, grout is pumped into the nipples, as previously described, until the shell

Figure 12 — Sketch shows arrangement of dovel plates for hot spot on furnace "I."



temperatures have been lowered to a safe level or until a coating has set-up which resists further pumping.

Three rather distinct types (or different acting) hot spots have been encountered and some illustrations have been made of each type.

One, which expanded diagonally and remained relatively narrow, occurred on Furnace "D." The location of the spot and its final shape is depicted in Figure 7.

Shell sprays and grouting held it inactive for a year before plates were required. Figure 8 portrays the arrangements of the plates and the time of their installation.

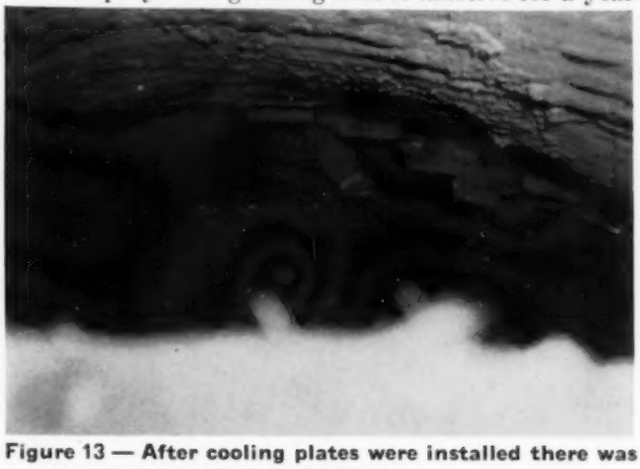
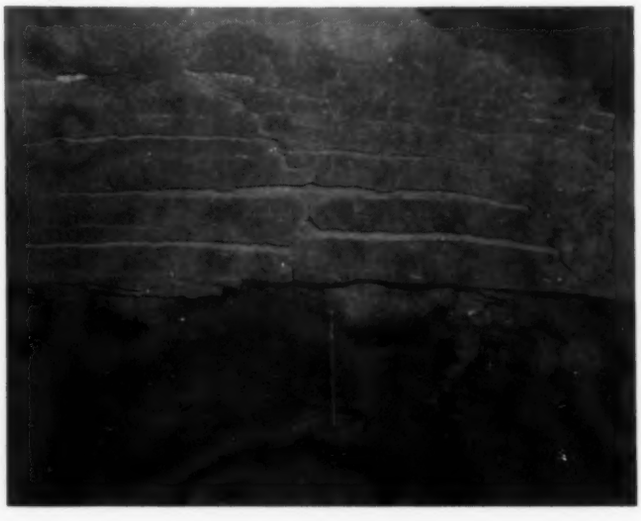


Figure 13 — After cooling plates were installed there was good build-up in the plates.

Figure 14 — Growth around cooling plates can be seen in this view.

Figure 15 — Another view shows benefit due to cooling plate.



The furnace was continued in blast 8 months after the initial plate installation.

Another on Furnace "E" was of a more circular nature. This spot was contained for nine months by sprays and grouting before plates were necessary. The installation of plates gained seven additional months of operation.

Figure 9 pictures the location and shape of the hot spot while Figure 10 shows the arrangement of the plates installed.

The third variation, while exhibiting a growth characteristic similar to the first, did not move in a diagonal direction but tended to spread out horizontally. Figures 11 and 12 show the hot spot and plate arrangement on Furnace "I" which remained in blast nine months after the first plates were installed.

As these furnaces were raked out, it was encouraging to find evidence, in most cases, of a build-up of grout and/or grout and burden material about these plates. In some places the coating was as heavy as 15 in. Several photographs (Figures 13, 14, 15 and 16) taken during investigations of burnt lines show this build-up quite clearly.

It is felt that the final grouting procedure played a considerable part in obtaining this result.

During a three year period, data are available on nine stack linings which are extended for an average of 13½ months with a maximum in two cases of 21 months and a minimum of three months. Table II lists the pertinent facts on each furnace.

The four point program developed to control hot spots with the view of extending the life of the stack linings has proven effective in most cases. It was not always possible to stop the expansion of the hot spot; however, some were contained for periods up to a year by sprays and grouting, and the stack life was further prolonged by the installation of dovel plates. The lining life gained and the additional tonnage of pig iron obtained easily justified the expense and effort involved.

Figure 16 — Cooling plate can be barely seen in this illustration.

TABLE II

Data on Hot Spots

Furnace No.	Date			No. plates	Date blown-out	Prolonged life, (months)
	Appearance of hot spot	Sprays — grouting	Plates installed, first and last			
"A"	9-16-51	—	9-16-51	6	12-10-51	3
"B"	7-16-51	7-16-51	5-23-52 8- 1-52	27	4- 2-53	20
"C"	3-14-51	—	3-14-51 9-15-51	21	11-15-51	8
"D"	10-14-51	10-14-51	10-10-52 4- 6-53	23	7- 9-53	21
"E"	12-11-50	12-11-50	10-20-51 4-13-52	30	5-22-52	17
"F"	4-18-52	—	4-18-52 9-21-52	38	2-18-53	10
"G"	5- 7-51	—	5- 7-51	34	8- 5-52	16
"H"	9- 2-52	—	9- 2-52 5-29-53	21	9-28-53	12
"I"	9- 5-51	9- 5-51	9-15-52 5- 1-53	30	6-16-53	21

In general, the furnaces operated reasonably well during the period of prolonged life. They were not unduly rough nor uneven in operation, and the tonnage and quality were close to normal expectations.

The contact pyrometer has become an invaluable tool when used as specified for detection purposes or for outlining an affected area.

While shell sprays are certainly not new, the use of a steam lance has resulted in increased effectiveness of this method of control.

Grouting has been extremely useful under certain conditions of packing and lining failure, and helpful when used to build-up a coating around the dovel plates.

The installation of dovel plates as the final step rounds out the program of control. It provides a means of continuing the furnace in operation when all else has failed.

This paper has been concerned with extending stack life after the appearance of hot spots; but, the basic problem of course is the prevention of such occurrences and the author would be remiss if he ignored this phase entirely. Therefore, if only to provoke more thought or discussion, the following list of items is presented as representing part of our approach to the basic problem of eliminating hot spot development:

1. Deeper research into the cause of lining failure.
2. Study of brick and mortar requirements.
3. Closer check on alinement of top and lining of the furnace.
4. Better brick laying practices and closer inspection of actual work.
5. Tighter packing of void between lining and shell —castable mix may be beneficial.
6. Better distribution of stock and blast.
7. Use of permanent stack cooling plates.

DISCUSSION

PRESENTED BY

WILLIAM O. BISHOP, Assistant Superintendent, Blast Furnace Plant No. 2, Inland Steel Co., East Chicago, Ind.

GUY WEHR, Blast Furnace Dept., Wheeling Steel Corp., Steubenville, Ohio

R. W. SUNDQUIST, Assistant Division Superintendent, Blast Furnaces, United States Steel Corp., Gary, Ind.

GORDON BAER, Manager, American Ore Reclamation Section, Koppers Co., Inc., Pittsburgh, Pa.

T. W. PLANTE, Assistant Sales Manager, William M. Bailey Co., Pittsburgh, Pa.

R. B. SNOW, Research Engineer, United States Steel Corp., Pittsburgh, Pa.

W. O. Bishop: We, at Inland, were very much interested in this paper, primarily because we have had only two hot spots in the last ten years and this doesn't give us too much experience.

I would like to comment just briefly on the first point that Mr. Sundquist made, which had to do with the detection of hot spots. On our last hot spot, on No. 2 furnace in 1952, we verified the temperature range which he gave in his paper. However it is difficult to use a contact pyrometer on the inwalls of our furnaces because of poor accessibility. Hence this type of temperature determination is not practical on a routine basis and would be utilized only when hot spots are suspected or apparent. We have another method of forecasting inwall failure available which we think has some merit. This is by the use of inwall thermocouples and the data they supply. They are primarily used as aids in the

satisfactory operation of our furnaces. In 1949, six months prior to one hot spot, we noted that the temperature range of three of the thermocouples ran 1600 or 1700 F with about 100 degrees variation while the fourth point was higher and at times over 2000 F for extended periods. We took the routine steps to correct this indication of irregular gas flow but in this instance were only partly successful, with the result that this one point generally remained on the high side.

Approximately six months later the furnace developed a hot spot in a vertical line with this high point. Thus we feel the thermocouples can give us some advance notice that all is not well.

Guy Wehr: It is quite possible that engineering is as responsible for the success or failure of a blast furnace lining as any other factor or condition.

To assure long life and successful campaign uniform wear of lining is a must. To get uniform wear, the distribution of burden must be absolutely uniform about the center line of furnace so that the resistance to upward gas flow is uniform on the entire circumference of furnace lining.

The furnace must be so constructed that the bells (during the whole campaign) operate up and down on the true center line of furnace. The failure of linings are the result when these conditions are not made possible.

Inwall cooling is generally recognized as protection against early lining failures and hot spots.

As to expansion of lining causing rupture to shell of furnace and proper precaution against, there seems to be two schools of thought. Some allow space and packing between shell and lining, and some lay up tight to shell. There has been many failures with both methods.

R. W. Sundquist: We have not lined any of our furnaces tight against the shell; however, we do have three furnaces in blast now in which we have filled the packing space with castable refractory creating approximately the same condition. With welded shell construction, we have experienced no difficulty with ruptured shells. We did split an old riveted shell when castable packing was used but have had no further trouble since welding the crack.

The point Mr. Wehr made about lining the furnace plumb and being sure everything is in line is sanctioned by us 100 per cent. We are doing everything possible to accomplish this in an effort to eliminate another one of the possible causes of hot spots. We have had some difficulty maintaining plumb furnaces after they are in operation; this difficulty may be due to the type of sand the furnaces are built on.

Gordon Baer: There is one thing I would like to ask. Instead of installing 270 stack cooling plates, I believe that was the total, after the furnace was in operation why did he not put those plates in at the time he lined the blast furnace?

R. W. Sundquist: For many years there have been operators for and against stack cooling plates in the blast furnace fraternity, and until recent years we fell in the latter category. For many years we had good lining life without stack cooling plates; however, we have changed our opinion and all furnaces are being provided with approximately 12 rows of permanent stack cooling plates as they are relined. One of our major problems in this project is providing a good, reliable high-pressure water system for plate feed.

Gordon Baer: Another item mentioned was the cause of these hot spots. I wonder whether anyone has made a check on drying out the furnace after lining, and if that has any bearing on the development of a hot spot more rapidly on one furnace than another.

We had an experience some years ago when pig iron was in great demand. We placed one furnace in blast without drying at all. We took the bricklayers out and started filling immediately, and not a single Btu of heat went into the drying of that stack. In 16 days we had a hot spot. I believe the furnace made about 250,000 tons before it was relined. It is evident the drying of the furnace may have some bearing on the hot spots.

T. W. Plante: I was glad to hear Mr. Baer mention drying out. I believe it has much to do with how long a furnace is going to last. I do not believe there is any operator here who has completed a lining without someone in the front office wanting to put it in blast immediately. I do not think anybody ever had enough time to dry out a newly relined furnace unless business conditions resulted in that furnace being kept idle.

It has been asked if we had any hot spots on the furnace in Chile. No. Before we put that furnace on we had the opportunity for a good dry-out, and it was the best of any furnace with which I have had experience. We had better than 18 days with at least 1100 F heat for drying and the furnace never showed the least sign of a hot spot. It was built on sand and we shook it up a bit with earthquakes, too.

R. B. Snow: In speculating as to the cause of hot spots, many engineers will think in terms of carbon monoxide disintegration and alkali attack. In respect to these two subjects, I might add the following information.

An examination of seven linings removed from the Gary furnaces in the past year revealed little general carbon deposition which was a common occurrence in furnace stacks some 10 to 15 years ago. Carbon was found in all cases just above and to the sides of the hot spots, but carbon deposition was not found in the upper stack area. Hence, we may question whether the disintegration was present before the hot spot formed.

A reaction between potassium in the furnace burden with the fireclay brick seems to be a more likely cause for furnace distress. Potassium compounds can react directly with the fireclay lining to form alkali-alumina-silicates which should cause a volume change within the wall and, with unfavorable conditions, such an altered section of the brickwork could peel away. Hot spots seems to occur at a level where the depth of the alkali attack often changes from a thick zone to a relatively thin zone.

Other factors such as bricklaying practice, expansion, and type of charge as well as general operation of the furnace must have some effect on hot spot formation, but we have not ascertained the relative effect of these factors.

We are continuing our examination of linings even more closely than we have in the past, and, through these examinations, we may find a means of eliminating hot spots or making a more permanent repair.

By JAY J. SEAVER, Manager, Jay J. Seaver Engineers, Chicago, Ill.

Developments in Design of Modern OPEN HEARTHS

. . . . many plants are finding that the most economical way to increase steel capacity is through improvements in existing open hearth units . . . . such improvements include such items as sealing of furnaces to stop infiltration, positive draft, clean gas, improved checker brick, and improved gas flow . . . .

▲ THE subject of open hearth is so broad that it is necessary to limit the scope of this paper to the construction and operation below charging floor level. The open hearth furnace has a background of about eighty-five years in this country. The first one to be designed, constructed and successfully operated here, was at the Bay State Iron Works, South Boston, in 1869. The late Samuel T. Wellman is credited with the design of this furnace, as well as having contributed much to the successful operation of it. This furnace was of five tons capacity with a general plan and sections shown on Figure 1.

The charging floor was at yard level with the regenerators, flues, valves and ladles in pits under ground.

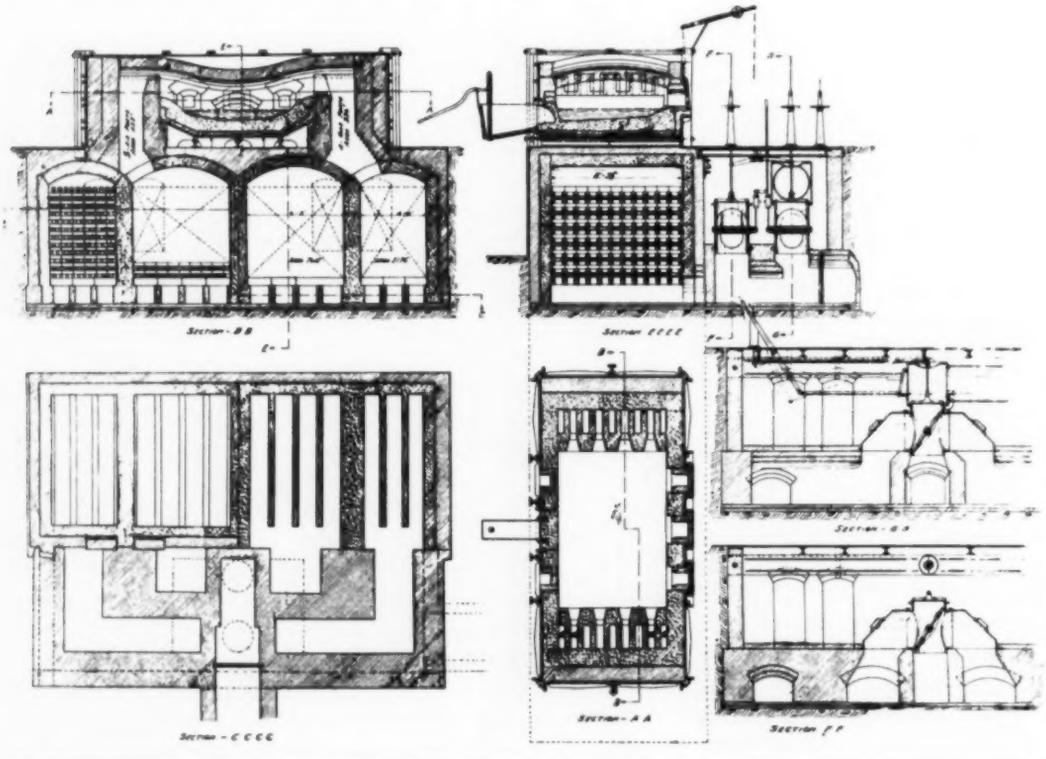


Figure 1 — The first open hearth furnace successfully operated in this country was installed in Boston, Mass.

In 1873 a so-called radical improvement was made to the open hearth, which consisted of raising the charging floor ten ft above general yard level and all other parts were raised accordingly. This change required the raw

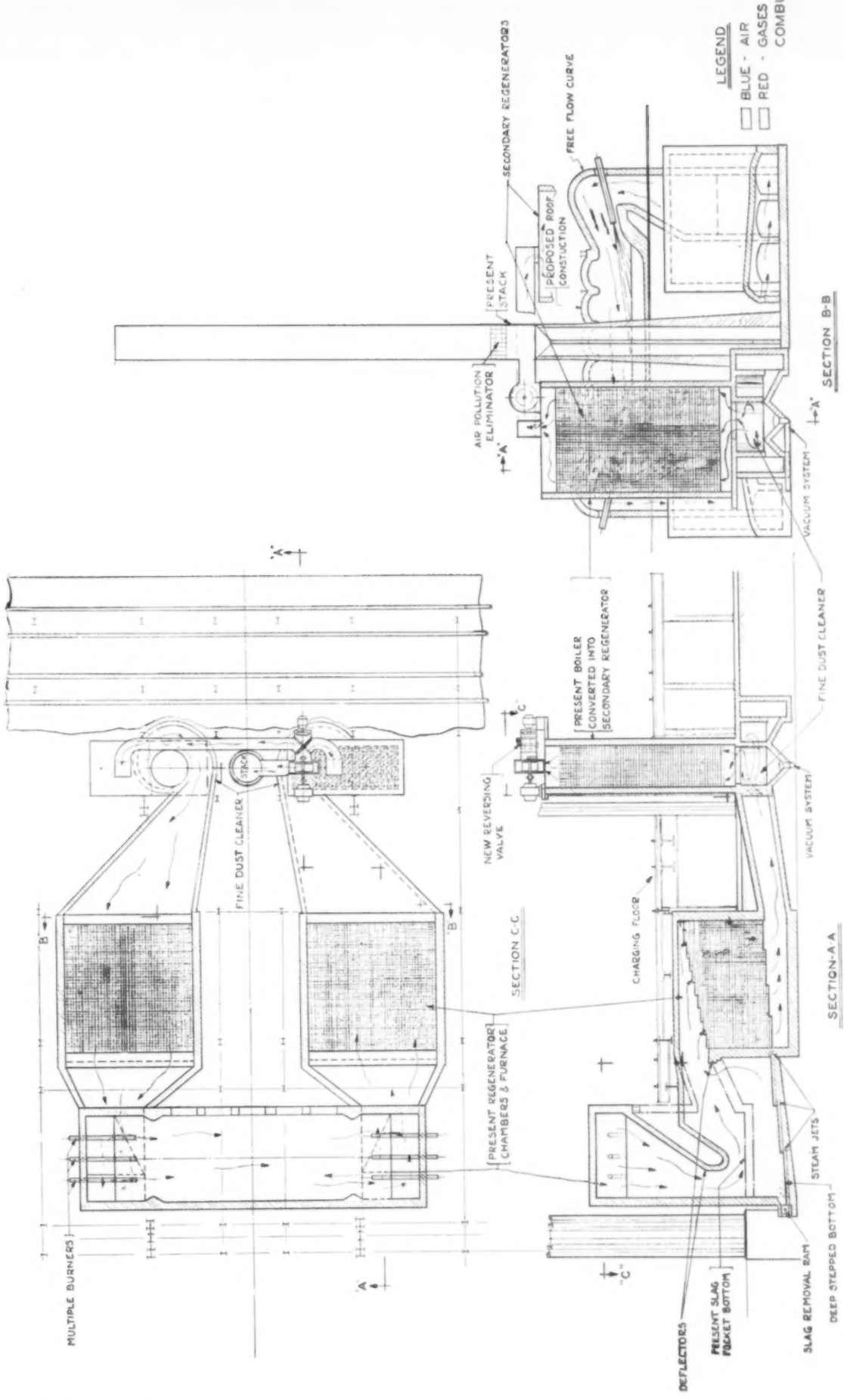


Figure 2 — Open hearth furnace design shown was proposed to eliminate some of the dirt.

charge materials to be raised from yard level to the charging floor by hydraulic elevators. Increasing the elevation gave greater accessibility to the furnace for inspection and repairs, as well as giving much more shallow casting pits.

Up until 1887, the regenerators for open hearth furnaces were placed under the furnace. At that time the regenerators were changed to a new location, which was under the charging floor, where they have been located ever since with some minor outside additions. The space available under the charging floor in many cases is limited, especially, as to height. In order to get the required heating surface with large checker openings to efficiently absorb the maximum amount of sensible heat available, it has been necessary to build external vertical regenerators outside and adjacent to the draft stack. Secondary outside vertical regenerators can be built in most plants. They have the advantage that the vertical flow of gas is much better distributed and controlled than the horizontal gas flow. Secondary regenerators have been built on a small scale. And although the results obtained at first were very good, the secondary checkers gradually fouled up with dust, so that their efficiency dropped and the draft was restricted as well.

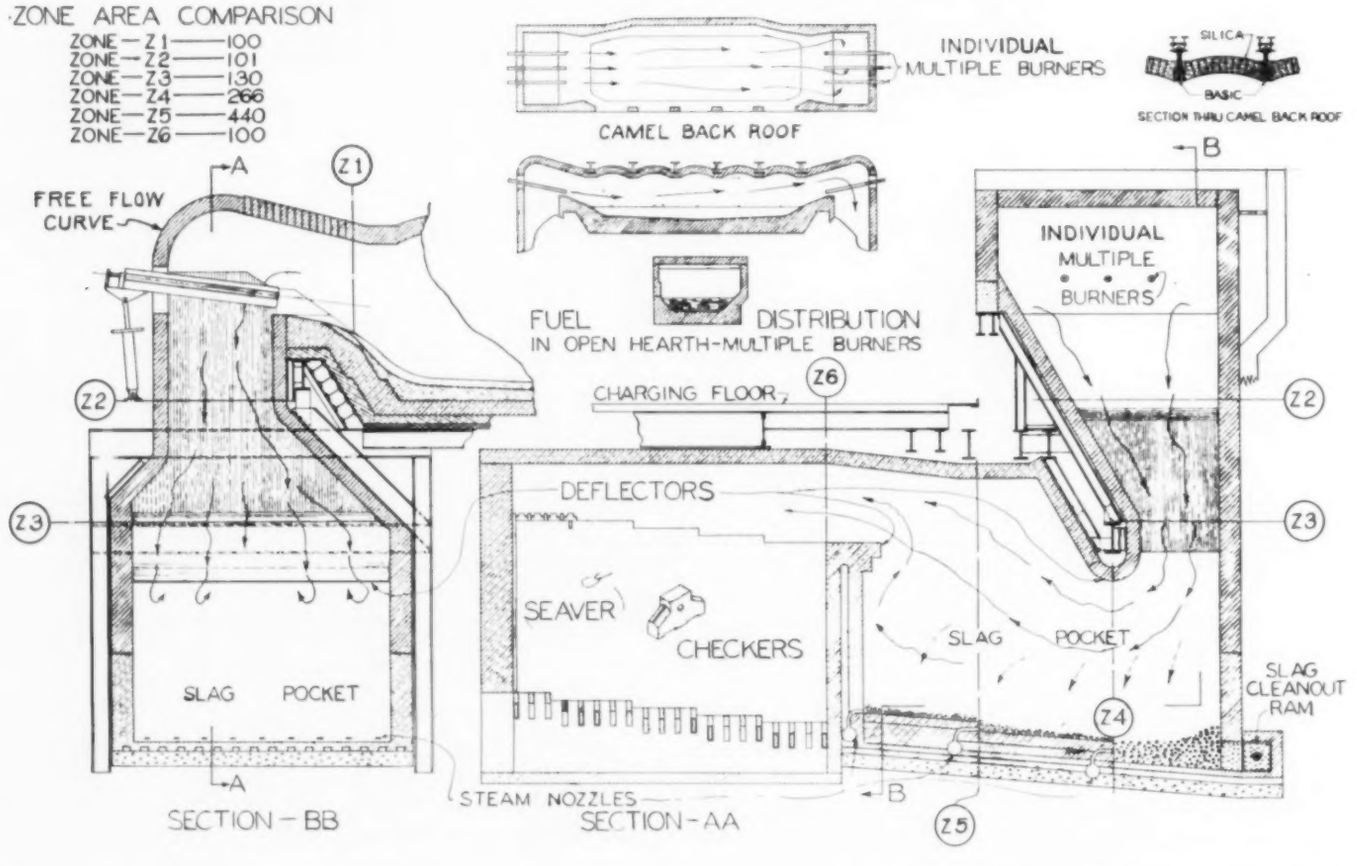
Figure 2 gives a general layout and shows the application of external regenerators as applied to an existing furnace. Here as you will note, the regenerators are proposed in the place of existing boilers, and the reversing valve is above them.

Checkers which serve a very important part in open hearth operation are of many kinds, sizes and designs. They are laid up with both open and solid joints to operate on one, two or three passes. Each plant usually has its own ideas of the kind of checker, the thickness of checker brick and the number of passes most advantageous for them. To date there is no absolute standard for any of the above decisions. Consequently, checker determinations are based on a compromise between small flues with high heating surface and large flues to keep them from being plugged up with solids. A practical yard stick for determining checkers should be the number of square feet of heating surface and weight of brick per cu ft of checker volume. However, there are so many variables involved now, that it is difficult to use this as a standard. If clean gas were available, that would eliminate several of the variables. If clean gas were available and properly distributed, it is recommended that the checker brick should be not more than 2½ in. thick, laid on edge, with one pass chimney flues having 4 x 4 in. openings and all brick locked in place. This would nearly triple the heating surface in most regenerators now in use without increasing their volume. This size checker opening would require increased velocity of the gases flowing through them, and since the rate of heat transfer is proportional to the velocity, the efficiency of the regenerator would be materially increased.

One item on which most operators agree is that they like to have high preheat. In order to get high preheat, the regenerators must have high efficiency. To get high regenerator efficiency, the gases must be cleaned and used in combination with high heating surface.

Better operating results from open hearth furnaces

Figure 3 — The deflector will aid in removing the solids from the furnace.



could be obtained, if the solids were removed from the products of combustion and disposed of outside of the furnace continuously. This can be done by the use of two refractory deflectors, a stepped sloping floor, steam manifolds with nozzles, ram and centrifugal pump. The first refractory deflector would be suspended from the inside wall of the downtake and connect up to the roof over the slag pocket as shown in Figure 3.

The gas passing down around the deflector would throw a high percentage of the solids out at the end of the slag pocket by gravity and centrifugal force. The second deflector would be a lip mounted on the vertical bridge wall as shown. The gas would pass over the slag pocket then come in contact with this second deflector which would throw down the remaining heavy solids on to the stepped sloping floor. At each step is a steam manifold and nozzles which would be turned on momentarily. The moisture would granulate the slag and the steam would blow it into the hydraulic ram. The ram would be actuated back and forth to push the slag into a small water pit. A centrifugal pump would pick the granulated slag up and deliver it to any desired location. Only fume would remain in the gas, the most of which would pass through the checkers out to the stack where it could be removed by a simple cleaner.

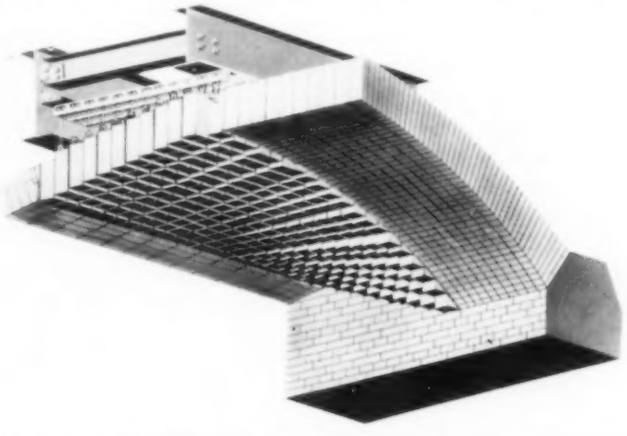


Figure 4 — Dead areas in regenerator have been eliminated with this design.

Gas distribution over the full width and length of the regenerator is very important. The uptakes or downtakes at each end of the open hearth furnace are usually the same width as the furnace, while the horizontal dimension parallel to the center line of the furnace is about one-third this dimension. The gas stream leaving the downtakes is inclined to be concentrated mostly in the middle third of the regenerator and travels in the line of least resistance, or it travels on an inclined path from the top of the bridge wall to the out going fantail. This leaves a wedge section of checkers on the bottom at the bridge wall end and a similar wedge section of checkers at the top on the outlet end which are inactive in absorbing or giving up heat.

This condition can be corrected by the above mentioned refractory deflectors, one at the bottom of the downtake and the second a lip deflector on top of the bridge wall. The first deflector causes the gas to turn a 90 degree angle and widen out into a thin ribbon stream the full width of the slag pocket. The gas then passes over the slag pocket settling chamber and impinges against the vertical bridge wall, on top of which is the second deflector, a lip leaning toward and into the gas flow. The second deflector, which is built across the full width of the regenerator vertical bridge wall, deflects the gas backward and upward to form an "S" reverse curve into a thin and wide gas stream. This directed gas stream impinges against the regenerator roof and gives a uniform distribution of gas over the entire top checker area.

All gas passages should be streamlined to eliminate eddy currents, wire drawing, dead areas and friction. Eddy currents are formed by sharp corners and are inclined to produce hot spots. Wire drawing which is caused by sharp and abrupt turns, produces friction and excessive wear on the brick work around corners. Dead areas are the result of poor distribution and circulation of the gas. Some dead areas in the regenerator corners have recently been eliminated by making the outgoing fantail opening a full width of the regenerator by the use of suspended arch construction. This is shown in Figure 4.

Summarizing, the open hearth furnace should be completely sealed up to stop air infiltration, a positive draft should be provided to compensate for climatic conditions and other irregularities, the gas should be cleaned and the solids removed continuously outside of the furnace, the heating surface should be made up of checkers with small openings and enough brick volume and surface to absorb and give up a high percentage of the sensible heat available, checker lancing should be eliminated, the gas should have good distribution, the bridge wall should be vertical rather than sloping, all gas passages should be streamlined, air pollution elimination should begin at the source. Some of these suggestions may seem radical, but in order to increase the efficiency of the open hearth furnace, they are improvements which have to be made.

DISCUSSION

PRESENTED BY

PAUL J. MASANZ, Combustion Engineer, Newport Steel Co., Newport, Ky.

JAY J. SEAVER, Manager, Jay J. Seaver Engineers, Chicago, Ill.

Paul J. Masanz: Mr. Seaver mentioned a few points which bring up questions. One of them pertains to baffles or deflectors. They seem to be in the position in the furnace where you have much erosion because of the high temperature and high flows. What type of ceramic material will be used in the furnace at these locations?

Now experience tells me that your fantails occasionally fall. Also high temperature causes the destruction of the side arch and slag pocket bulkhead which are eaten away so they have to be patched, yet Mr. Seaver proposes to install deflector plates of ceramic materials at this position. I wonder what material will be used for the deflector plates.

The second question in my mind relates to the lining of gas passages and at the same time adding additional deflector plates. I have always understood the more deflectors and obstructions you have in a flow of any

kind the more turbulence. The question is how do you use deflector plates and at the same time smooth out the flow?

Jay J. Seaver: I will take the last question first. We are not creating turbulence. All we do is to make a longer passage for the gas, taking it from the narrow neck which is about a third of the width of your regenerator, and widening out the whole width of the generator chamber by putting in the deflector. It does not create turbulence. All it does is deflect the gas and give you a thin ribbon of streamlined flow.

With the second deflector we throw the gas back up against the roof so you get the gas distributed over the complete area and the whole width. It is a reverse turn.

Paul J. Masanz: What type of ceramic material is used for the suspended arch, and also on the bridge wall?

Jay J. Seaver: The contact brick wall can be built in different ways. You can build a solid wall or two walls with an air space in between, so you can aircool it from one side to the other, if it is required. Now three carloads of brick are used to make the sloping floor and wall, and this makes it easy for the dirt to get into the checkers. Of course, you have some expansion on your checker brick too which pushes on the wall. For that reason, I say the checker brick should be locked with a simple lock and laid up loose with first quality fire brick or basic brick. The suspended arch should be of special high temperature or basic brick, or metal casing.

Paul J. Masanz: Speaking of the suspended wall deflector plate, does it make a horizontal line or arch across the opening?

Jay J. Seaver: Yes.

BLAST FURNACE STOVE CLEANING

By L. R. ROBINSON*

▲ PRESENT designs of stoves generally follow the use of three units that will heat the requisite volume of blast to a sustained 1500 F temperature for a period of 90 minutes, with a 10 to 15 per cent reserve capacity. For a 1400-ton furnace, this duty would call for about two million pounds of effective checker brick contained in a stove shell 25 ft in diameter by 120 ft high. The heating surface in a stove of this size would approximate 225,000 sq ft. The flue size would average approximately 2 in. in diameter, or 2 in. by 2-in. square checker openings.

Many accounts have been reported by furnace operators in technical papers concerning the benefits derived from the efficient use of hot-blast stoves in reducing coke rates, increasing furnace production, and generally improving the operation of the furnace.

Cleaning is one method of improving efficiency. The cleaning of flues in blast furnace stoves by the rotary rod method is accomplished by rotating a flexible spring-steel rod to which are attached suitable tools and cutters, beginning at the bottom of the flue and continuing up to the top. The flexible spring-steel rods are long enough to progress from outside the base manhole entrance to the top of the flue. They are rotated during their progress and withdrawal by means of a gasoline-driven rodding machine. A crew consisting of capable supervision and thoroughly trained labor is used with each rodding machine. After the flues have been cleaned and opened from the bottom up, the cleaning is completed, where necessary, by removing any remaining slag or glaze from the surface of the top checker brick with air-operated or electric flue-cleaning machines.

Among the advantages of the rotary rod method of cleaning stoves are:

1. Maximum efficiency in cleaning stoves having reduced sizes of flues under top basket-weave construction, transitions, etc., without having such top flue construction removed.
2. Removal of a maximum number of plugs or obstructions at the point of origin allows dust and debris to fall to the bottom of the flue, where it can be removed easily.
3. Reduces the "off wind" time of the stove, inasmuch as the cleaning can be started within 24 to 48 hr after the stove has been opened at the top and the bottom.
4. Permits faster cooling of stoves, owing to the gradual increase during cleaning in the number and size of air passages.
5. Reduces the time required for cleaning stoves as much as 5 to 10 days.
6. The restoration of from 95 per cent to 99 per cent of flue openings in the stoves of the small multihole checker design. The percentages for basket-weave designs have been slightly less, but in most instances restoration of the larger flues has been above 85 per cent, even in very old stoves.

An example of the savings realized by an operator in the Pittsburgh district in cleaning three stoves is as follows: The straight-line heat was increased approximately 280 Fahrenheit degrees per stove, and, estimating an 80 per cent utilization factor, this averaged 224 degrees of hot-blast increase. The operator estimated his savings in coke alone to be approximately $332.00 per day, and that nine days operation of each stove paid for the cost of the cleaning.

These items are but a few of the tangible economies that will result in such preventative maintenance:

1. The normal stove life will be greatly extended.
2. Expensive retopping and brick repairs to the checkers and combustion chamber will be minimized.
3. Fuel saving will result both from decreased coke rate and decreased power costs in the operation of blowing engines, since obstructed air passages create additional friction loss.
4. Increased iron production.
5. Smoother furnace operation, since reserve heat in hot-blast temperature will be available when required.

*President, Robinson Pipe Cleaning Corp., Canonsburg, Pa. From paper presented at Blast Furnace, Coke Oven and Raw Materials Conference, Philadelphia, Pa., April 18, 1954.

COLOR — the second value in paint

By N. A. MASON
Manager Maintenance Paint Sales
Pittsburgh Plate Glass Co.
Pittsburgh, Pa.

. . . . the efficiency of any operation can be improved materially through the use of color . . . . it is necessary that the hues used be selected with care and placed in such a way that they will improve the environment for the benefit of the worker . . . .

▲ THE National Paint, Varnish and Lacquer Association advertised the protective quality of paint for a number of years through a slogan, "Save the Surface and You Save All." This very broad statement was also limited in that the saving was confined to inanimate objects of steel, masonry, wood, etc. But what about the human element — all important to the successful operation of any plant, institution, hospital, or even the American home?

It is this human element that controls the efficiency of any operation — large or small — and sooner or later we must appraise it and make adjustments in our thinking and attitude if we are to be considered profitable operators. The American standard of living and way of life will force us to do something about this human element if we continue to neglect it.

Most people are considerate and appreciative of small contributions to their welfare and happiness. Everyone has experienced a relationship that made him feel very good, but cost the benefactor nothing but a little effort.

Color is one of these little things that costs very little — imagination, appreciation and the will to do something for the enjoyment and benefit of others.

The real power of color was not fully realized until after World War I. Henry Ford was making automobiles by the thousands, and you could have any color of finish, or protective coating, you desired so long as it was black. In 1925, color was used in a limited way to attract people, or customers, to manufactured products offered for sale. In my office there is a small brochure on the subject printed in 1925, and the title is "Selling With Color." The brochure contains many illustrations in color, and even today you still see some of the same colors on the products illustrated.

There has been much talk about color in the factories the past several years. Several large manufacturers of paint, and some small ones, have promoted a color system of industrial maintenance painting. What is the fundamental purpose of color when used in protective coatings applied to machinery, equipment, walls and ceilings of our factories, institutions, hospitals, schools and the home? The answer to such a question is: "For the enjoyment and benefit to human beings, restricted to a given environment for several hours each day."

An automatic machine will produce so much no matter what the color of the protective coating, but when we add the human factor as a part of the operation we also add limitations and in some instances complications. For example, how well can the operator see the operation and add raw material as required? Is it easy for him to feed the machine or is it a difficult visual task? Is it easy to distinguish between the material being fabricated and the machine body, or does it require concentrated visual acuity? These are but a few of the elements that establish limitations, and each one can be easily adjusted with color.

About twenty years ago, color was promoted to the medical profession as a mild therapy. The medical people were receptive to the idea and conducted a number of controlled experiments. These early experiments are a matter of record and established color as a contributing factor in the treatment of patients confined to hospitals and other medical institutions.

In 1940, when America was busy arming their Allies

against Hitler and oppression, one or two paint manufacturers, with experience in color for hospitals, reasoned if color was good for people confined to a sickroom, why not try color as an environment factor in manufacturing plants where people, busy at a task, were confined for several hours at a time. One of the first complete color jobs, as applied to industry, was the old Curtis-Wright Plant in Buffalo, N. Y.

We tried color in the machine shop as an efficiency factor. Our purpose was to improve working conditions for the people so as to make it easy for them to produce more with less fatigue, eye-strain and nervous tension. After making a careful study of the habits of the workmen on the job, and by experimenting, it was found color could improve efficiency, production and the mental attitude of the worker. This application of color in industry definitely established color as the second value inherent to a can of paint.

Perhaps it would be interesting to know some of the basic thinking back of the color selection and placement employed to improve the environment in the Curtis-Wright machine room.

First the place was very drab and uninteresting, glare was a problem for a portion of the day as one elevation of the building was continuous steel sash and glass from dado height to the roof line. At times, seeing conditions were terrible and housekeeping was something talked about but never accomplished. The machines, such as lathes, shapers, drill presses and boring machines, were filthy dirty, covered with grease and dirt to the extent it was difficult to tell if they were ever painted.

Naturally, our subject offered as many possibilities for improvement as the country maid on her first visit to a city beauty shop.

The following principles were employed in transforming the machine shop from an ugly duckling to a pleasant enjoyable place to work.

1. *Color contrast* — Color contrast is a principle used to attract and hold attention. This principle was used when selecting color for areas of machines where the actual work was being done. It assisted the worker in that it told him immediately where the material being fabricated began and the machine body left off. The body of the machine, or that part considered nonfunctional, was painted in a color known to have excellent eye rest properties. This color was developed by combining nature's various hues of green into a single color we called vista green. In comparison to gray, the vista green color receded and caused the operational area to stand out and be easily seen. Also, the color green requires very little eye adjustment in order to bring it into proper focus when used as a background color. It so happens the human eye is constructed in a manner that permits the sensations of green to focus on the retina, not in front, as red, or behind the retina surface as blue. This is the reason why you see so many factory interiors painted in a hue of green.

2. *Brightness contrast* — Brightness contrast is measured by the difference between the light reflectance of two colors. For example, a good commercial flat white reflects about 90 per cent of the light striking the surface, and black about 2 per cent. White walls absorb about 10 per cent of the light and a black wall about 98 per cent of the light. If these two colors are used in combination, the brightness contrast ratio would be 90 to 2 or 45 to 1. Naturally, such a condition would be terrible in so far as seeing conditions are concerned. It would be a terrible shock to the eye as the gaze would travel from the black surface to the white and back again. The end result would be somewhat similar to going into a dark movie on a very bright sunny day. As you enter you are temporarily blinded because the pupil of the eye has contracted to a pin point in order to keep out the bright light. As you enter the theatre the small amount of available light cannot enter the eye since the pupil is practically closed. The muscles of the eye begin to function and the pupil opening becomes larger, and allows more of the available light into the eye and in time we are able to see and even distinguish detail.

This same condition would happen, to a smaller degree of course, if the factory walls and ceilings are white and the six foot dado black. A worker at a machine located near a wall painted in this fashion would be working in an environment where the background was dark, naturally the eye would compensate for the condition and the eye muscles would open the pupil to allow more light into the eye. As the worker shifts his gaze from the dado area to the upper wall area, which is white, the brightness would momentarily blind him. Time would be lost in the adjustment to the brightness, and more time lost as the gaze shifts back to the task.

Brightness contrast is therefore controlled through color selection. Various hue values have different light reflection factors, therefore, the color engineer selects colors with the proper brightness contrast for good, easy seeing conditions without discomfort. Lighting experts say the brightness ratio between reflecting surfaces should be within the limits of 1 to 3.

3. *Camouflage* — Color used to hide or obscure objects is called camouflage. Nature uses camouflage very effectively in the coloring of birds and beasts. The color expert uses color to hide objectionable clutter, unsightly construction details, etc. At times we paint overhead above the illumination level flat black to hide clutter. The eye stops at the light level and most people are not conscious of the obstructions above. This principle is used in department stores, restaurants and school corridors that have open ceilings in order to make pipe and ducts readily available for repair.

We often paint out objectionable clutter or obstructions by using the same color as used on adjacent surfaces. Overhead pipe, ducts, braces and structural members are not conspicuous when they are painted out in the same color as walls or ceilings.

4. *Eye rest surfaces* — Color can provide eye rest surfaces from a critical visual task by employing the color principle of complementary colors or by using a color known to be "easy on the eyes."

Complementary colors are those containing between them all three primary colors. For example; blue-green is the complement of red since the two hues contain between them the three primaries, yellow, red and blue.

The color receptors on the retina of the eye are very sensitive and can be easily overstimulated by looking too long at one hue. Nature has a way of providing speedy eye rest under such circumstances by employing afterimage. In all cases the color of the afterimage is complementary in color to the hue causing the overstimulation.

In the event a workman is machining a red plastic for long periods of time he will develop blue-green spots before the eyes which may cause him to leave the job for several minutes of rest. To overcome such a condition, a background screen of grayed blue-green could be moved behind the machine to act as an eye rest surface and provide the eye relief necessary to prevent absenteeism from the job.

5. *Morale building surfaces* — Color that adds interest and individuality to an environment is called a morale building color.

This is a psychological factor and is used to give a lift to the workers as they go from one area to another within the plant. Such colors can be used in rest rooms, cafeterias, lockers, stairways and corridors. The colors selected must blend and add interest to be effective.

Each project a color engineer works on must be considered as a custom job so to speak, as all factors must be considered and weighed before an effective color plan can be developed. In too many cases those responsible for painting have thought of color as something to hide dirt, dust and grease. If this principle is followed, you are catering to those responsible for housekeeping and subjecting the majority of the workers to unhealthy working conditions. If white is used on all ceilings and walls for greater light distribution, you are favoring those responsible for plant lighting and may be causing workers to work under conditions injurious to their eyes and general health.

Color can also be employed to improve safety by using the National Color Code to identify hazards to safety. When a color is used for such a purpose, always reserve the use of that color for the particular purpose, otherwise the safety feature will lose its identity.

Color, the second value in paint, can contribute materially to the efficiency of any operation, provided the hues used are selected with care and placed in such a way to improve the environment for the benefit of the workers.

DISCUSSION

PRESENTED BY

D. N. EVANS, Assistant Superintendent, Field Force Department, Inland Steel Co., East Chicago, Ind.

D. E. WHITEHEAD, General Lubrication Engineer, Crucible Steel Co. of America, Pittsburgh, Pa.

D. N. Evans: The Inland Steel Co. has an organized yearly painting program that averages 55,000 gal of paint, and there are 29 approved colors and shades used in this program. The value of color in a steel mill is recognized by Inland and in the administration of this program a plant-wide specifications manual is the guide. This manual dictates the type and color of paint as well as the method of application, resulting in providing a plant that gives a systematic appearance as to the use of color.

Color use as directed by the building inspector's group, who administer the painting program, is flexible; however, procedure calls for clearance through this agency, before deviations in the painting program will be permitted.

This type of program enables all departments to readily comply with an overall plant program, and does not leave individual departments to create an effect of color conditions that may please them, but would be fundamentally unsound as to the overall effectiveness and value of proper color use.

We believe with the author, Mr. Mason, that the value of color in any painting program is a factor that should receive the highest consideration. One of the recognizable assets received from attractive surroundings is the motivation to good housekeeping, an asset that no steel mill or other industry can overlook for efficient operation and desirable safety results.

An added advantage of color may be had by using it for the purpose of identification, such as painting a pipe line to indicate what is inside of the pipe or the painting of hard hats to identify a group of people. Fire equipment and safety equipment are typical objects to be identified by color.

While our ability to use the advantages of color contrast, lightness contrast, camouflage, eye rest surfaces and morale-building surfaces is limited in some phases of the steelmaking process, we do attempt to follow those principles and believe them to be fundamentally sound and will give to our people, the advantages of a well-appearing work environment.

D. E. Whitehead: In connection with color and its application to steel mill maintenance painting, the source of color standards and selection is a major consideration since a common language for basic colors, shades and tints would facilitate standardization and simplification of any painting program.

It appears desirable to embrace the source of U. S. Federal Government color standards i.e. "Federal Specification TT-C-595 Colors-Ready Mixed Paints" which represent consolidation of color charts from the many government agencies, including the armed services, and particularly since these are already reference standards between paint manufacturers and between paint manufacturers and consumers. Specific colors contained in the Federal manual are indicated as reference standards for the selection of colors for such application as pipe identification color codes by the American Society of Mechanical Engineers, American Standards Association and National Safety Council. It could well be the purpose of steel mill painting engineers to further develop the popularity and industry wide use of these standards to the advantages of color program simplification, both procurement and application wise, and correlation of industry wide color safety training.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

CLEVELAND SECTION

Thursday, July 28, 1955, Golf Party, Elyria Country Club, Elyria, Ohio.

More Production through CHEMICAL MAINTENANCE

By A. DAVID NESBITT
Dowell, Inc.
Dearborn, Mich.

. . . . chemical cleaning has been very effective in reducing downtime in the steel plant . . . . many types of piping can be cleaned, in many cases without appreciable interference with operations . . . . good results also have been obtained in cleaning open hearth checkers and checkerwork in blast furnace stoves . . . .

▲ THE high production schedules encountered by the iron and steel industry through the war and postwar years, and ultimately predicted for 1954, stress the importance of keeping production equipment running smoothly. Smoother, more economical operation might be possible if shutdowns to take care of troubles could be avoided or minimized, in cases where the problem cannot be eliminated during operation. This would be true, whether in all out production or on reduced production schedules. Chemical maintenance procedures have minimized downtime, and in many cases have eliminated shutdowns entirely. The term "chemical maintenance," as used in this paper, will be defined as: the use of chemicals; the use of high pressure jet streams or hydraulics; or the use of a combination of chemicals and hydraulic methods, for removing operational deposits from iron and steel plant equipment.

These deposits may be on heat exchange surfaces and have cut down heat transfer. They may be in flow equipment and have caused unnecessary reduction in flow capacity, or increases in power costs (Figure 1). Dirt, paint, oil or rust found on old or new equipment may be the problem, contributing to unnecessary corrosion problems in the future if not promptly handled.

Chemical maintenance can solve most of these problems economically for the steel plant operator with an absolute minimum of trouble.

The problems attendant to cleaning metal equipment and refractory masses will be discussed in this paper, from the standpoint of attaining successful, safe, economical results. A description will be given of some of the factors involved. Materials of construction, the chemical or physical characteristics of the deposits, the solvents available and the importance of safe operating practices will be discussed. The chemical procedures and the hydraulic jet procedures will be described. Finally a description of how a combination of chemical and hydraulic jetting procedure was used to

Figure 1 — Deposits on heat exchange surfaces cut down transfer rates.

TABLE I

Inorganic Deposits

	Metal ions	Negative radicals
From water	Ca Mg Na K Fe Mn	$CO_3^=$ HCO_3^- $SO_4^=$ Cl^- $S^=$ $O^=$ OH^- Silica
Attack on metals	Fe Cu Zn	

surmount an extremely difficult problem will be presented.

The use of chemical solvents to remove offending deposits is covered in the literature. Blast furnace cooling systems (2)*, boilers (7), (10), open hearth cooling systems, heat-treating furnace cooling systems, electric furnace cooling systems, coke plant gas scrubbers, condensers, coolers, ammonia stills, water lines (5), and gas lines illustrate a few of the possible applications. The problems involved, however, should not be underestimated. To accomplish the successful removal of deposits with solvents it first is necessary to know something about the deposit.

There are three classes of deposits encountered. They are: (1) inorganic materials derived from mineral sources; (2) organic materials or carbon compounds, and (3) mixtures of inorganic and organic materials. Table I illustrates a typical heat transfer situation. It is possible to find calcium, magnesium, sodium, potassium, iron and manganese metal ions in the water. From corrosive action by the water during operation, iron, copper and zinc and others may also be found, depending on the materials of construction. These metals may be found in various combinations with the negative radicals: carbonate, bicarbonate, sulphate, chloride, sulphide, hydroxide and various silicates. Many of these combinations, such as those shown in Table II, are water insoluble and end up as constituents of the fouling deposit. (1).

TABLE II

Chemical Compounds in Inorganic Deposits	
Carbonate or basic carbonate	of Ca, Mg, Fe, Mn, Cu, Zn
Oxide or hydroxide	of Fe, Mn, Cu, Zn
Silicate	of Ca, Mg, Fe, Mn, Cu, Zn
Basic chloride	of Cu
Sulphide	of Fe, Cu, Zn
Sulphate	of Ca

Organic deposits usually occur in coke plant equipment, or in water or steam equipment, where oil or other organic material are contaminants. They may also be found where conditions are favorable to the growth of living organisms. There are thousands of different organic deposits. They may be light oils, highly polymerized rubbery material, or coke deposits. It becomes necessary to classify them into groups (Table III), so that chemical methods may be satisfactorily applied to their removal.

In removing inorganic materials, chemical reactions convert the insoluble materials into new compounds that are soluble and can be carried out of the unit in solution. Many times this is not possible with organic materials and they must be either physically dissolved in a suitable organic solvent, or broken loose and disintegrated by an aqueous solvent sufficiently for their removal. The application of hydraulics has resulted in the removal of many of those organic deposits, which were economically impossible to remove with solvents alone.

Combinations of inorganic and organic deposits sometimes present special problems, further complicating the situation. The type of organic material, the chemical composition of the inorganic material, and the physical properties of the deposit, all have a definite bearing on the method of attack to the problem. It may be possible to use an acid-chlorinated solvent emulsion, or it may be necessary to use alternate alkaline-acid stages. Oxidizing solvents may be the answer. Each problem must be considered separately. Of necessity the completeness of the chemical engineer's experiences and resources will determine whether or not a satisfactory answer can be found.

TABLE III

Classes of Organic Deposits
Vegetable origin
Saponifiable
Non-saponifiable
Petroleum origin
Soluble in carbon tetrachloride
Insoluble in carbon tetrachloride
Coal origin
Soluble in benzene or pyridine
Insoluble in benzene or pyridine
Miscellaneous

There are many solvents available for chemical deposit removal, but costs, fire hazards, health hazards and corrosive nature limit those that can be used practically.

In general, acids, alkalies, chlorinated solvents, hydrocarbons, oxidizing agents, and concentrated sulphuric acid are employed.

It is no longer necessary to be afraid of using acid in metal equipment. The development of better inhibitors and their proper use had made this possible (12).

Figure 2 shows a bifurcate boiler tube exposed for 96 hours in the laboratory to hydrochloric acid, inhibited with one type of inhibitor. This is equivalent to approximately 16 service jobs. Corrosion has taken place at areas where this tube was welded during fabrication. Figure 3 shows a similar specimen that has been subjected to the same test, using acid containing a different inhibitor. It can be seen that the importance of inhibitor and its proper application should not be underestimated.

The materials of construction have a very important bearing on the choice of solvents for the job. Cast iron and low carbon steels have good resistance to most common solvents, however, temperatures must be held much lower when applying inhibited acid to cast iron

*Footnote—Numbers refer to bibliography at end of this article.

Figure 2 — Test shows some corrosion took place in welded areas.

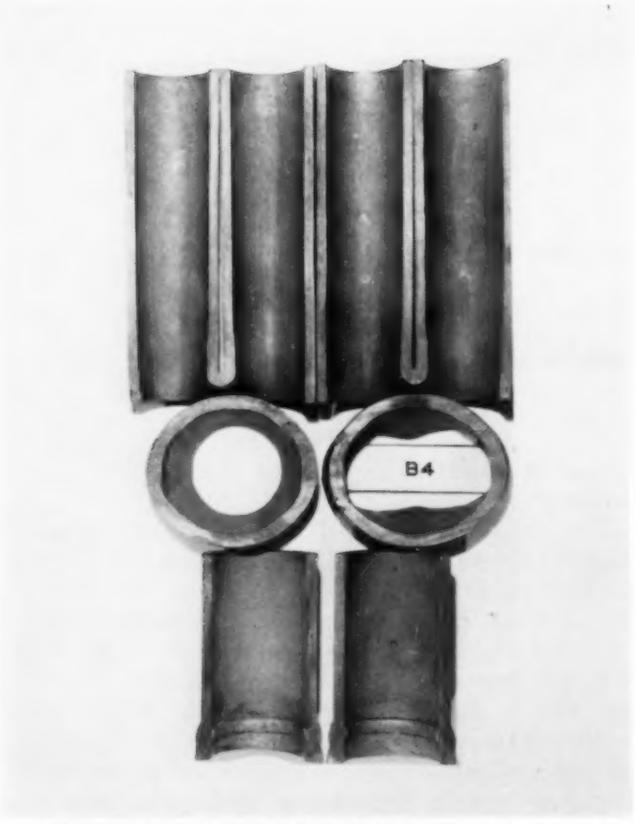


Figure 3 — With the right inhibitor, corrosion can be markedly reduced.

equipment. Stainless steel can be cleaned successfully; however recent investigations indicate that the chemical engineer must be careful to choose the proper solvent depending on the type of stainless steel involved. Acids or strong alkalies cannot be used in cleaning either galvanized or aluminum equipment, unless the galvanizing can be sacrificed.

Inorganic deposits usually are removed with acids, because the water insoluble materials are converted to new compounds which are soluble in aqueous solution. For example, insoluble calcium carbonate is converted by hydrochloric acid into calcium chloride, which is water-soluble. This is shown in the following chemical equation:

$$CaCO_3 + 2HCl = CaCl_2 + H_2O + CO_2$$

The oxides to a varying degree react in much the same manner, forming soluble iron or other metal chlorides. Iron sulphide is converted to soluble chloride, with the liberation of poisonous hydrogen sulphide gas. Calcium sulphate deposits are insoluble in inhibited acid and present a special problem in chemical maintenance procedures. Silicate deposits may be removed by acid solutions containing additive material, or by alternate alkaline and acid stages.

The subject of solvents should not be left without a description of the hazards involved. In spite of the inhibitor, there will be a small amount of hydrogen formed by reaction between the acid and the metal. Hydrogen is very explosive over a wide range of mixtures with air. Care should be used to conduct vented gases to open spaces away from sources of ignition. Smoking, the use of flame tools, and other sources of ignition should be prohibited during the job.

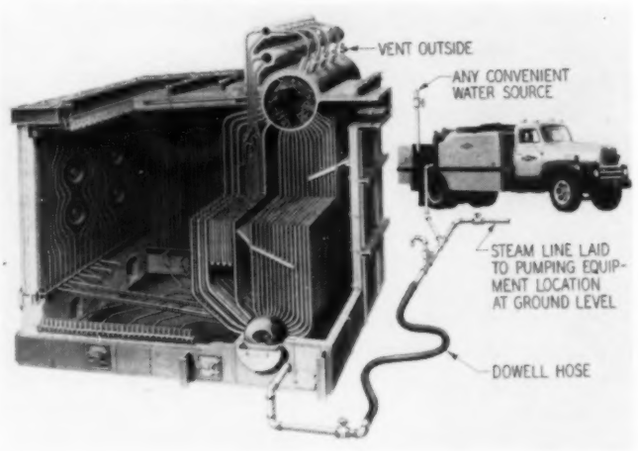
Proper safety clothing is required for personnel handling acids, alkalies, inhibitors and other cleaning solvents.

Where hydrogen sulphide is encountered in the reaction, gas masks and sometimes special gas scrubbers should be available. Policing of the area also becomes important.

Carbon monoxide is a common problem encountered by the steel industry in their operational safety practices. It is mentioned here to emphasize the importance of having properly trained chemical engineers supervising the cleaning operation, especially on or around operating equipment.

The chemical method consists essentially of filling the unit to be cleaned with the proper solvent, at temperatures and concentrations found necessary by ade-

Figure 4 — In boilers, reaction rates can be tested during the reacting period.



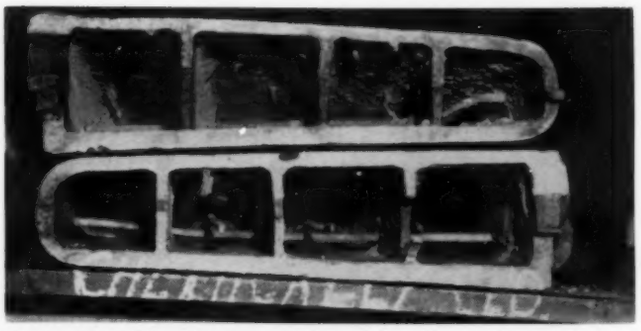


Figure 5 — Circulation baffles did not prevent solvents from giving maximum results.

quate preliminary laboratory work. External pumps, air, inert gas or the chemical reaction may provide any necessary circulation. In general, any equipment whose design permits the cleaning solvents to contact the fouled surfaces, can be serviced by chemical maintenance procedures. Existing connections, with occasional minor changes, are generally satisfactory for the introduction of the solvents and for vents. Dismantling is minimized or entirely eliminated. Many times it is possible to do in less than 24 hours, what might normally take many weeks.

Many previously impossible problems are now being solved by the application of chemistry and engineering. For example, boilers can be cleaned by filling them with solvents and testing the reaction rate during the reacting period (7), (10) (Figure 4). The proper solvents are introduced through existing blowdown connections or feed lines, and the unit is filled to the desired level. After a short reaction period, the solvents are drained and the unit is flushed out twice with water and given a neutralizing boil-oil with alkaline material.

Recently an open-hearth waste-heat boiler, whose volume was 6,000 gal, was cleaned in 12 hours time. Not only was it impossible to clean this type of boiler adequately by any other method, but 3,644 pounds of deposit was removed by chemical maintenance procedures. The deposit, consisting of iron oxide, hydrated calcium phosphate, magnesium hydroxide and calcium carbonate was removed with very little downtime.

In another case, laboratory analysis of drain solvents indicated that over 9,000 pounds of deposit, consisting of hydrated calcium phosphate, magnetite and magnesium silicate, was dissolved from a 500,000 lb per hr industrial low-pressure boiler. This work required about 30 hours. It formerly required three to four weeks to mechanically clean. The increased availability is obvious. The removal of $\frac{1}{16}$ in. of deposit made it possible to carry additional load on the boiler easily, not to mention the full savings realized.

In the erection of new iron and steel plant equipment, chemical procedures have been applied to lubricating oil systems, hydraulic control systems and oxygen systems. Mill scale, rust, oil, grease and paint have been removed with excellent results.

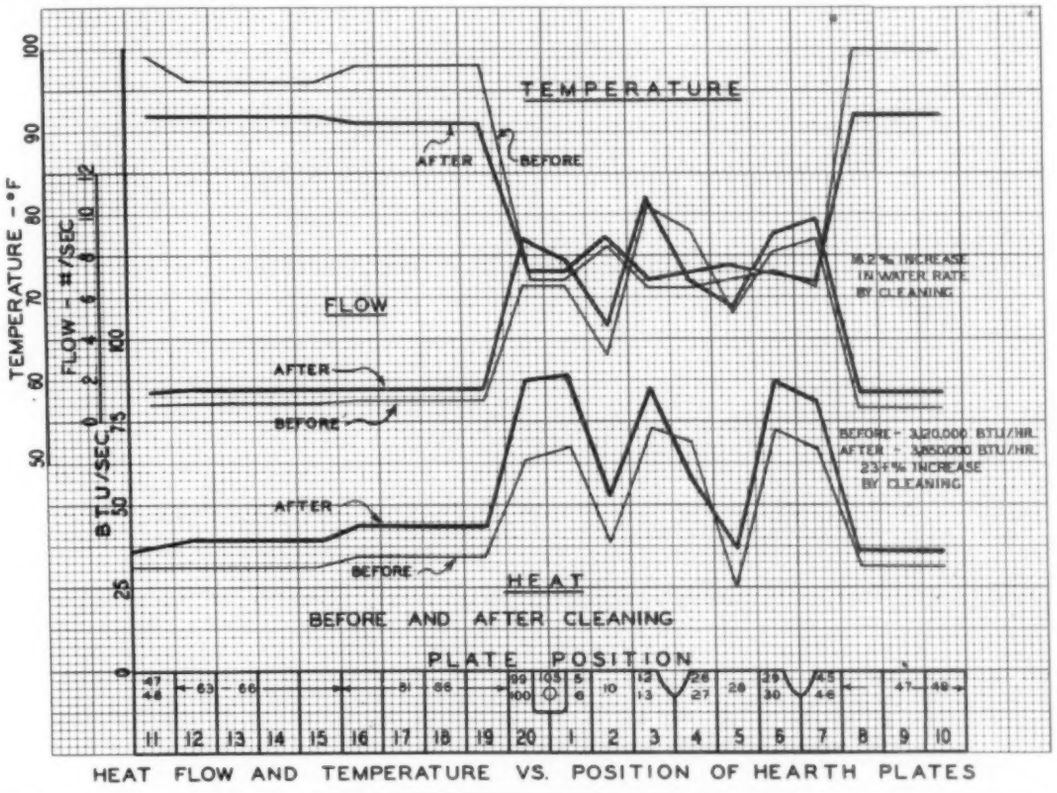


Figure 6 — Tests on heat pick up before and after cleaning hearth jackets show improvement obtained.

HEAT FLOW AND TEMPERATURE VS. POSITION OF HEARTH PLATES

Blast furnace hearth, bosh and inwall coolers have been cleaned by circulating chemicals through the coolers and all of the associated piping during normal operation.

Figure 5 shows a bosh plate, after servicing. It can be seen that the circulation baffles did not stop the solvents from giving maximum results.

Chemicals do not skim over pits in the piping. The more complete cleaning of the pits tends to postpone the possibility of further corrosion by local action on the corroded area. The pits are cleaned and not skimmed over as in other cleaning methods (13). Experience has also shown that the cleaner surfaces remain clean longer. Heat pick-up by the circulating water can

be easily measured to show the effectiveness of the work.

The lower curve in Figure 6 shows the heat pick-up before (light line) and after (heavy line) the servicing of the hearth jackets on a modern blast furnace. The ability of the hearth coolers to do their job was increased completely around the blast furnace, after chemical service. In this case the water picked up 23 per cent more heat subsequent to chemical maintenance procedures. Thus, in a few days time and without disturbing normal operation, not only the coolers but the associated piping were returned to maximum efficiency.

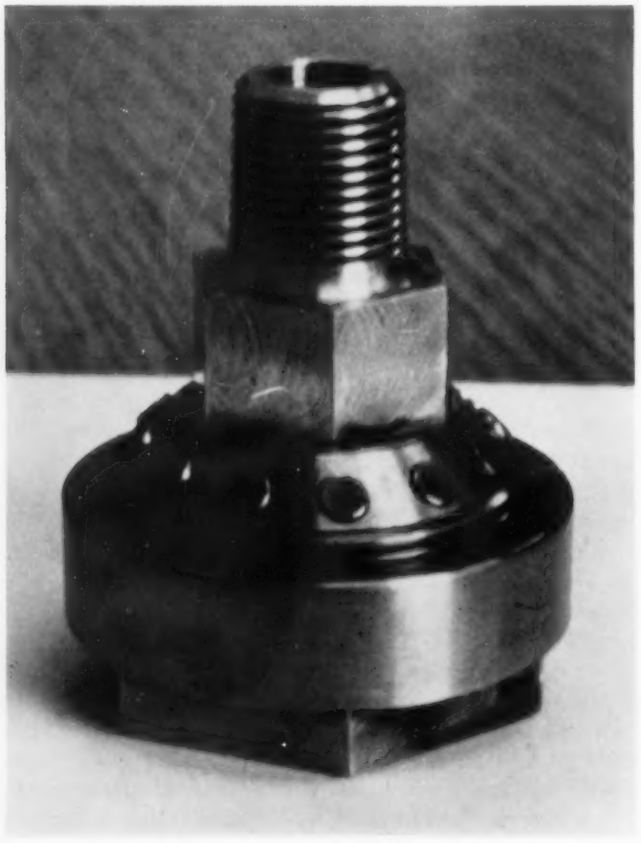
When the enormous investment required to finance the installation of these coolers on a blast furnace is considered, it merely makes sound reasoning that a 20 per cent loss in their efficiency should be very important in protecting the thickness of cooled refractory and aid in the prevention of break-outs.

The application of high pressure jet streams to the removal of fouling deposits from both operating and shut-down steel plant equipment has proved economical, safe and effective.

Hydraulic jet cleaning is best described as the use of water or chemical streams discharged from a shaped nozzle at pressures up to 4500 psi, and directed at the offending deposits. The cutting energy is purely kinetic when using water. The problem resolves itself into proper nozzle design to insure adequate transmission of the discharge energy to the material to be removed, with a minimum of loss.

Coke oven and blast furnace gas mains, ranging from 16 in. to 8 ft in diameter, and operating at pressures of from ½ psi to 50 psi, have been cleaned during operation, employing this method. There are countless examples where a few hundred dollars expended, have avoided shutdowns on blast furnaces, boiler houses, and other equipment. It is a matter of simple arithmetic, for example, to realize that 24 hours lost production on a 1400-ton per day blast furnace is a permanent loss of at least $70,000 in pig iron value alone, at today's prices. This does not take into account the problems of getting the men together, the scheduling necessary for other equipment dependent on the gas or iron production, or any of the courses the operator might have to take to eliminate the problem by other methods. Very few maintenance expenses can be paid for so quickly.

Figure 7 — A number of different types of nozzles are used for various jobs.



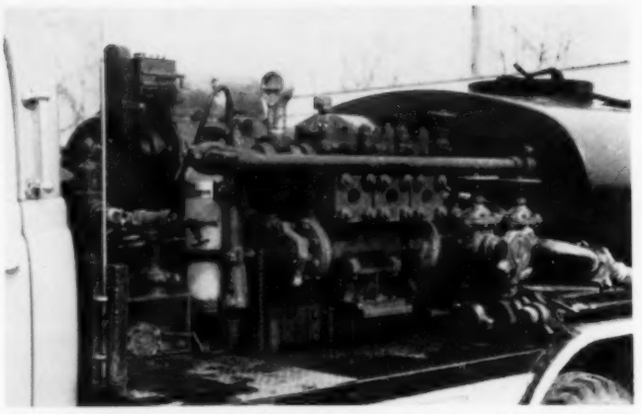


Figure 8 — Pumps used are of the positive displacement type.

Gas meters, dust legs, gas valves and gas washer cones illustrate a few other instances where this type of service has removed the trouble without shutdowns. Recently a total of 36 blast furnace gas burners, on three boilers, were cleaned hydraulically while they were on the line. Hydraulic jet cleaning techniques have been successful in cleaning coked heat exchanger tube bundles, wood hurdles from coke plant scrubbers, tank interiors and many other applications.

The combination of chemical and hydraulic jet procedures is being used to clean open hearth checker chambers, both during a normal campaign and immediately before shutting down for a new roof. The time saved during the shutdown period or the increased draft and heat exchange efficiency of the checkers made possible during operation has increased furnace availability and production (14).

Increases in production and reduced maintenance costs directly attributed to this type of cleaning procedure have led to its continued and increased use in many open hearth shops. Up to November 23, 1953 a total of 72 open hearth checker cleaning jobs were completed by our company and 52 of them were completed in 1953.

Special nozzles have been designed to do various jobs. They range from simple inserts that can be installed on a pipe or in a pipe fitting, to nozzles designed to pull themselves into pipe lines and at the same time cut the deposit from the walls. A typical nozzle is illustrated in Figure 7. It can be seen that this type of tool would be capable of sweeping the deposit that is removed back to the original entrance point for removal.

More recent designs will make it possible to put a forward jet into operation merely by an adjustment of pressure used.

The available pumps are capable of sustained operation at pressures over 3500 psi and can deliver adequate capacity to supply these nozzles. For example 30 gpm at 3000 psi would not be uncommon.

Figure 8 shows the type of positive displacement pump normally used in this type of work. It is mounted on a heavy truck and is driven by the truck motor. This gives it complete mobility and thus is available at any location.

Armored hydraulic hoses or hydraulic tubing are used to conduct the high pressure water or chemical streams to the jet nozzles.

The use of hydraulic jets has been successful where other methods have been too slow, too costly or have

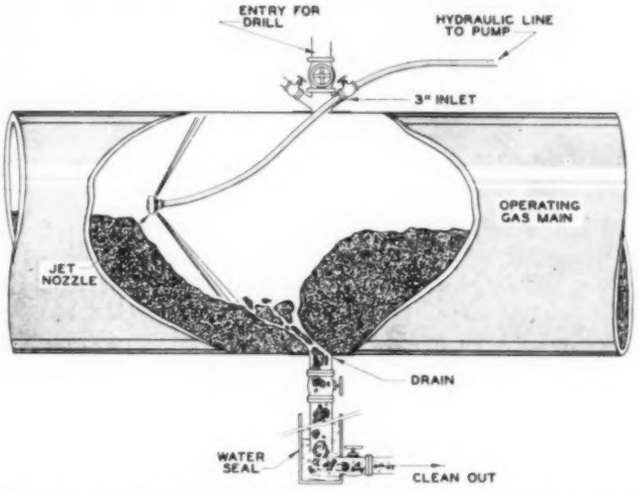


Figure 9 — Cleaning jets were inserted into the blast furnace main without shutting down.

failed completely. To illustrate the application of high pressure jet streams and the combination of chemical application and high pressure jet streams to steel plant problems, two applications will be described. The first will be the cleaning of a large blast furnace gas main during operation, and the second will be the cleaning of a refractory mass type of heat exchanger—the blast furnace stove.

A blast furnace gas main, 6 ft in diameter, and carrying approximately 130,000 cfm of gas had a pressure drop of 14 in. of water over less than 100 ft of length. This section contained a segmental orifice meter. It was first necessary to construct a special valve array so that the cleaning jets could be introduced into the main, without shutting down (Figure 9).

The valve array consisted of short 3-in. pipes welded to a short 8-in. nipple on opposite sides and at approximately a sixty degree angle with the center line of the 8-in. nipple. It was made to such an overall length that the center lines of the 3-in. nipples intersected the center line of the 8-in. nipple at a point that would be in or below the plane of the metal in the surface of the gas main. Valves were installed on all three openings. This assembly was then welded to the gas main at a point slightly down stream from the orifice meter. A special packed drill was used to cut a 6-in. hole in the gas main under pressure through the 8-in. valve. Immediately below this installation, an 8-in. nipple was welded on the bottom of the main and after installation of a valve, this was drilled through in a similar manner, for a drain. A water seal was used to carry away the dirt and water used for jetting. A specially designed jet head was attached to hydraulic hose and introduced through a packing device into the gas stream.

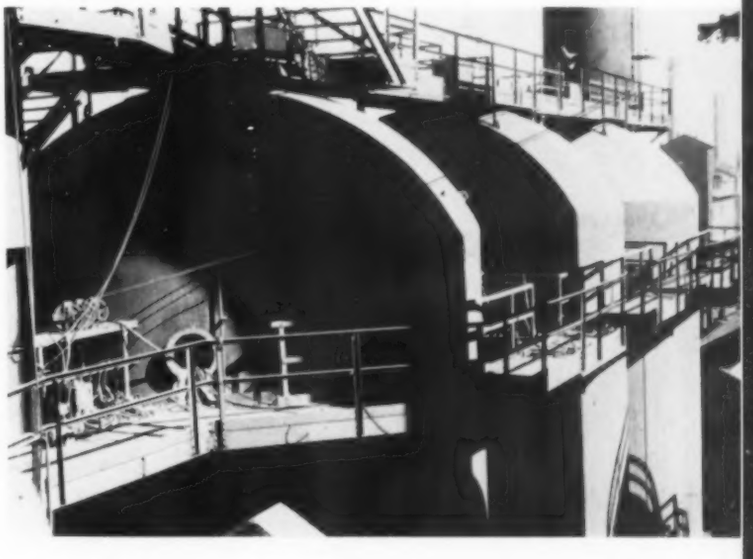
This jet nozzle has a series of removable, shaped discharge orifices mounted at a 45 degree angle to the axis of the hose so that when operating at 3000 psi it will pull, as well as cut and sweep. By feeding and returning this jet both ways from the entrance connection, the section was cleaned in two days time and returned to a normal total pressure drop of 4 in. of water, which was directly across the meter and correct for the flow conditions. As the cleaning progressed, the jet tool became audible in its back and forth passage through the main, tending to confirm its cleanliness and indicate the progress of the operation. Gas masks were worn by the men during this work, and the area was kept clear of other personnel.

It should be pointed out that for extremely high gas velocities it is necessary to work from up stream to down stream to keep proper control of the jet head.

The section described above was in the gas main, feeding the power house and the coke ovens. It was being fed by one blast furnace and was on the down stream side of any valves, water seals, and gas cleaning equipment. The gas systems of two other blast furnaces feed into this main at a point down stream under similar conditions. The alternative would have been to reduce the wind on the blast furnaces and blow through the bleeders or shut down entirely, isolate and purge the main and actually enter the line and dig out the restricting material. The problem was solved using hydraulic jets with a minimum of trouble. Furnace operation was improved as a result of reducing the top pressure on the blast furnace by 10 in. of water, and no detrimental effects were experienced.

Many times these deposits can be more difficult to

Figure 10 — Blast furnace stoves can be cleaned by the chemical method.



remove or surrounding areas may be such that men cannot work in the area for extended periods. For example chemical sprays were installed on an operating 8-ft diameter gas main in the top of a steel plant power house where the heat was unbearable. Chemical solvents were pumped through these sprays actually dissolving the deposits and relieving the situation during operation. Ramifications of these procedures are often practical solutions to many other problems in the steel plant.

The blast furnace stove problem we would like to describe is probably the most difficult test the chemical and hydraulic maintenance procedures have ever been applied to (Figure 10).

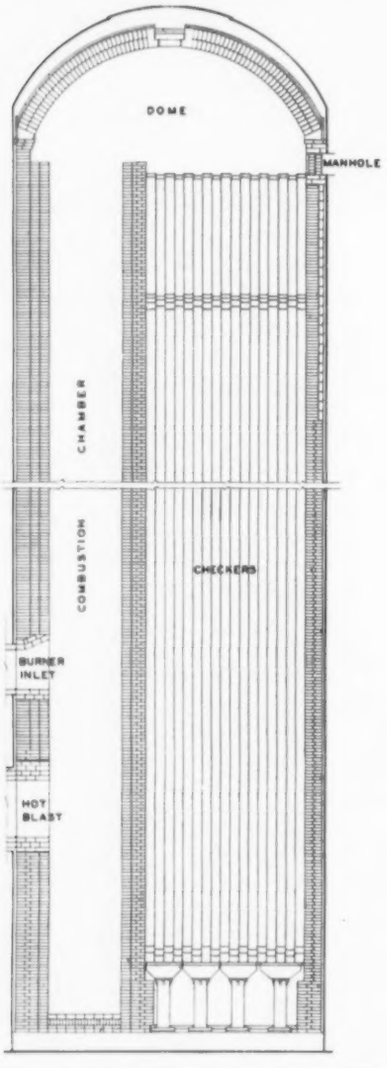


Figure 11 — Cross section through stove which was cleaned.

This stove was of the side combustion chamber type, 110 ft high overall and 25 ft in diameter (Figure 11). The checkers or heated refractory mass, were of the cluster square type consisting of about 480 blocks per course. There were approximately 3400 sq holes $1\frac{15}{16}$ in. on a side, extending completely through the checkers for approximately 89 ft. It should be pointed out that all work was done on this stove while the blast furnace was operating, necessitating many extra safety precautions because of the constant gas hazard present. The conditions leading to this work can best be illustrated by describing the stove's operation the week previous to being taken out of service.

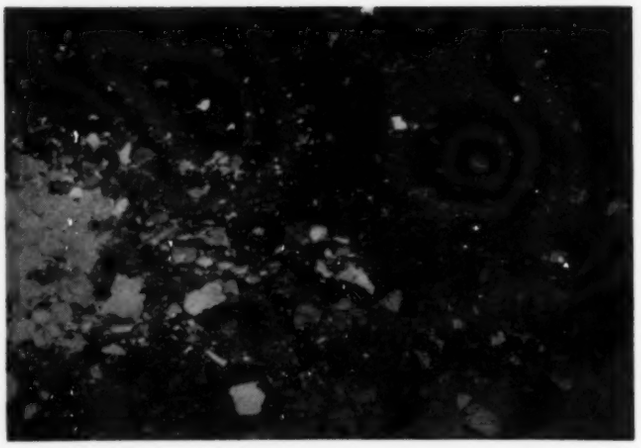


Figure 12 — Bad condition after opening of dome is illustrated in this view.

Normal desired dome temperature was 2000 F. It became impossible to get the stove to take gas due to blow back at the burners, because of checker plugging. Immediately before being taken out of service, 1700 F dome temperature was the best that could be attained. Even this temperature dropped to 1100 F and below, within an hour after putting the stove on the furnace. Extra coke was being used to get more heat in the furnace. The cold blast mixer valve would start to close immediately, after it was put on the furnace. The stove in effect forced itself off the line at 4 pm on the first day and was used as a mixer to cool the checkers down, the rest of that day and until cool enough to be opened. The conditions present within the stove were attributed to inadequate gas cleaning equipment and alkali attack from the dirty gas on the hot refractory.

Figure 12 shows the conditions immediately under the dome opening at 2:30 pm on the third day, immediately after the stove was opened. The white material is the sealing brick from the overhead dome opening. It was impossible to even imagine what the checkers looked like, from the coke-like mass observed. It was decided that after satisfactory brick had been uncovered, proper cleaning procedures could then be applied. Time was important. Manual digging was started immediately and the remains of the top checkers were removed.

Figure 13 shows the appearance of some of the first holes, about one foot down, at 10:30 pm on the third day. At 1:00 pm on the fourth day, 32 in. of checkers had been removed. The last two courses were carefully removed one block at a time by hand, onto a tarpaulin.

Figure 14 shows the general condition remaining subsequent to the digging operation on top of the checker chamber. This photograph was taken from the cleanout door. A typical area was chosen at this point and is illustrated in Figure 15.

There were very few holes open and most of those, although open at the surface, were plugged a few inches down. Experience indicated that the first operation should be to thoroughly soak the checkers with low surface tension acid solvents. Although the deposits are generally highly insoluble silicate materials, experience has shown that this operation greatly reduces

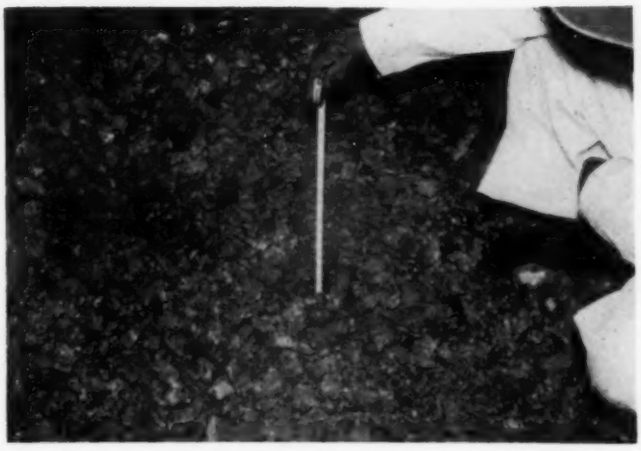


Figure 13 — View shows appearance of first holes about one foot down in the stove.

their strength by reacting with some of the soluble materials.

The first objection that may be raised by the reader is that this would hurt the refractory. Tests were conducted on typical stove refractory brick by an independent laboratory, with the solvents known to be practical and economical. They involved saturation of the refractory with the chemical solvents and after drying, subjecting them to load tests at temperatures above 2200 F. Pyrometric cone equivalents were also obtained on them. The results indicated that there was little or no effect on either the strength or refractoriness of the brick.

The entire checker mass was soaked with chemical solvents, starting at 7 pm on the fourth day. Eight hours were required for this operation. The saturated refractory mass was then allowed to stand for eight hours. The first reaction to this is that it can do very little good, however, Figure 16 shows the same area as in Figure 15, after this operation, indicating that there has been considerable effect on the plugging material by the chemicals. Subsequent hydraulic jetting work indicated this to be definitely true.

Hydraulic jetting was started at 12:50 pm on the fifth day. The nozzles used were $\frac{3}{16}$ in. located on the end of a 6 ft lance of steel hydraulic tubing, connected to high pressure hose. Pump pressures up to 2400 psi were employed using water. This lance arrangement was introduced 25 ft into each of the 3400 holes. A follow-up procedure with a steel weight was used for a check on results. It was found that 25 ft into the checker holes was adequate to completely clean the checker. The hydraulic jetting operation was completed at 9 pm on the sixth day.

Figure 17 shows the result, as compared with Figure 12, which shows the condition five days before. The steel weight used to check the results is also shown. It can easily be seen that the square openings were completely clean, even the square corners. Most of the hard crust deposit was also removed. This should add to the ability of the brick to absorb and liberate heat in operation and make for a better working stove. It should be pointed out that where lateral passages are present, they can also be satisfactorily cleaned by this method.

Some 14 to 16 in. of fine granulated material and

Figure 14 — General condition after digging is shown in this view.

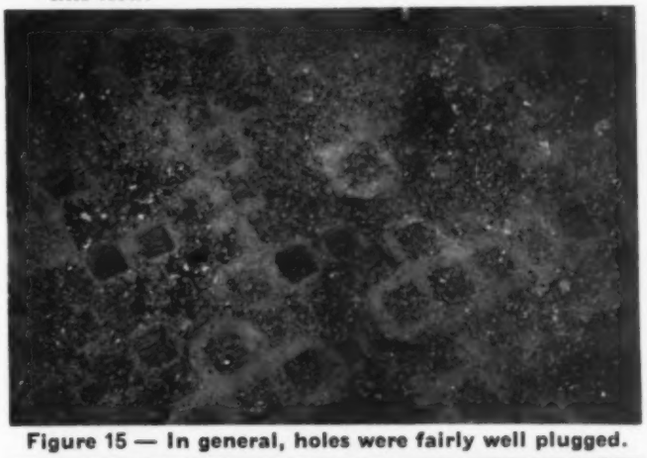


Figure 15 — In general, holes were fairly well plugged.

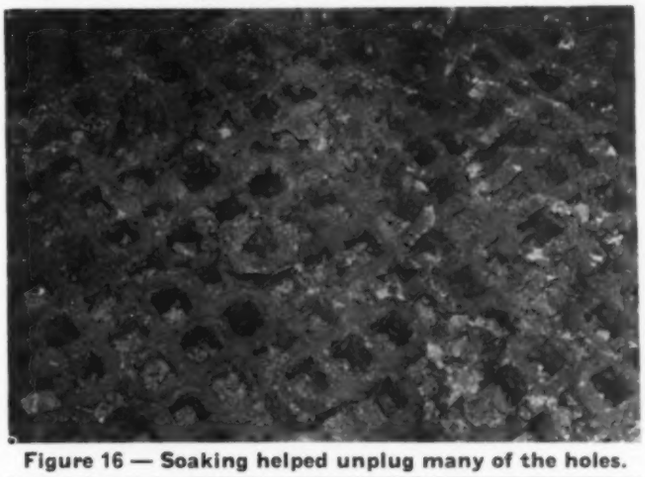
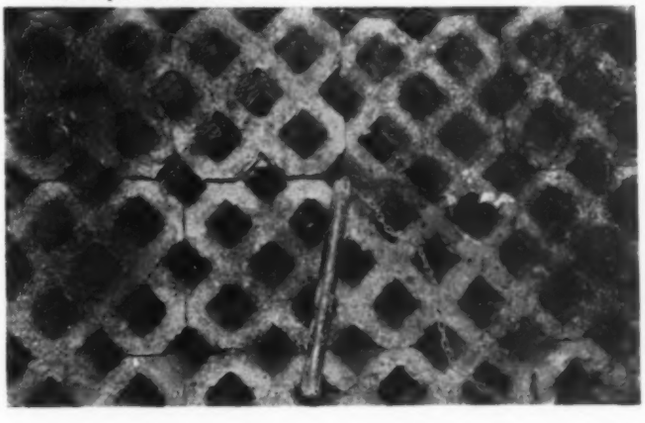


Figure 16 — Soaking helped unplug many of the holes.

Figure 17 — A very clean stove was the result of the chemical operation.



mud were then dug out of the bottom of the stove and all liquid pumped out. The operators estimated that approximately eight tons was removed from the bottom of the stove. The stove was immediately sealed up and the drying operation was started at 4 am on the seventh day.

This stove was put on gas for 48 hours to dry out, and then was put on the furnace to complete the drying operation. The stove returned to normal operation on the blast furnace with less than ten days outage. Many stoves that have refractory inserts in the checkers, to increase the mass and heating surface, have been cleaned using solvents only, with excellent results.

The procedures described for cleaning heat exchangers, water lines, gas lines and the blast furnace stove apply equally well to many other problems. This highly specialized field of chemical engineering is not a cure-all for all of the operator's headaches. Technical service personnel cooperating with the operating and maintenance men, can eliminate many of them and relieve others satisfactorily. This is not a field for hit or miss methods but a challenge to well trained, competent engineers and chemists.

By reducing or eliminating downtime, chemical maintenance can give the operator smoother operation and more production.

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DISCUSSION

PRESENTED BY

C. MELVIN SMITH, Plant Engineer, Rotary Electric Steel Corp., Detroit, Mich.

A. DAVID NESBITT, Dowell, Inc., Dearborn, Mich.

C. W. CONN, Manager Open Hearth and Electric Furnaces, Ford Motor Co., Dearborn, Mich.

WILLIAM J. SCHARFENAKER, Maintenance Shops Superintendent, Ford Motor Co., Dearborn, Mich.

H. F. LESSO, Metallurgist—Open Hearth Control, Great Lakes Steel Corp., Detroit, Mich.

R. S. MOORE, Assistant General Sales Manager, Harbison-Walker Refractories Co., Pittsburgh, Pa.

WARREN HART, Superintendent Electric Furnace Building, Ford Motor Co., Dearborn, Mich.

CHARLES RICH, Assistant Masonry Superintendent, McLouth Steel Corp., Trenton, Mich.

J. C. ANDERSON, Superintendent Blast Furnaces, Great Lakes Steel Corp., Detroit, Mich.

ROBERT CLEVELAND, Production Analyst—Blast Furnaces, Ford Motor Co., Dearborn, Mich.

A. DONALD SHATTUCK, Assistant Superintendent—Coke Plant, Blast Furnace Div., Great Lakes Steel Corp., Detroit, Mich.

C. Melvin Smith: Can this be used for cleaning soaking pit checkers?

A. David Nesbitt: At the present time, I would say no. We think that it might have an application. I would hesitate because of the touchy nature of the ceramic exchanger involved. The high temperature refractory is relatively thin. It would be very touchy and easy to ruin it. I think it might ultimately have something to offer but we would rather walk slowly at the moment.

C. W. Conn: In the jobs on open hearth checkers that you mentioned, did you use a chemical solvent?

A. David Nesbitt: Yes, sir. You are thinking that it is the pressure. Actually, we cannot prove either way. We think that the chemicals add to the work and we have done considerable of it recently. I think probably the best way to describe why we think that the chemicals add to the result is to describe an experiment. We set up a special furnace to heat samples from the open hearth checkers (you should bear in mind the variation of checkers, depending on what is being fired in them.) By using a drip test with chemicals on the hot deposits, which is not too similar to the actual application under pressure, we found that the materials we were using would have a definite effect on the hot material which should approach the actual condition in the furnace, with the exception of draft and should therefore increase the operations effectiveness. In cleaning open hearth checkers, we would like to do it while the furnace is on draft. The trend has been, however, to possibly drag it out so that there is not too much chilling in the checker chamber or hampering of

operations as a result. It is also felt that reduced size and high nozzle efficiency and high pressure will get more energy to the deposit with less fluid, thus less checker chilling, and thus accomplish considerably more work than large crude nozzles at lower pressures.

William J. Scharfenaker: Do you still employ the technique that you used in our place a few years ago in the early days? I know you have improved a lot; we all have, but do you separate the chemical solvent and allow a soaking period before you go in with the hydraulic pressure?

A. David Nesbitt: It would cool it down, unless it was immediately previous to shutting down. The work we have to do, we have always tried to do on an operating furnace. We are trying to reduce jet sizes and increase pressure and still get the energy to the deposit in order to minimize the cooling effect that we would have on checker chambers. It more or less resolves itself to refinement of design of the jet tool that we are using.

William J. Scharfenaker: What size jet are you talking about? What are you working with these days? How many gallons per minute? What size orifice?

A. David Nesbitt: There again it depends on what size your checkers are and so forth.

Member: A couple of years ago, I watched you people do a job at Sparrows Point on a checker chamber. The checkers were running kind of hot and they were a mess. You could not do anything with them at all. I wonder if you have made any progress working on that type of material.

A. David Nesbitt: That is one of the unfortunate situations that we can very easily get into. There is a tendency to give us the nastiest condition available to try it on. Many times, I think a practical answer can be had sooner if we did not have to work on the extreme conditions. Were those fired with tar?

Member: No, they were not.

A. David Nesbitt: The deposit in the open hearth checker system varies so much with the fuel fired and the operation of the furnace. There again each problem is an individual one. In fact, sometimes you can do one thing in one end of a shop and you cannot do it in the other end of the shop and I cannot tell you why.

C. W. Conn: Where you feed the chemical solvent into the stream of high pressure water, it is dissipated so fast that its effect was very negligible; whereas if you would do something in the open hearth checkers like you did in the blast furnace stove that was described, it might help considerably, and make the job of removing the deposit a lot faster, easier and cleaner.

Have you ever done that in an open hearth checker, put the solvent in and let it soak?

A. David Nesbitt: No, we have not. It is a good idea and we would like to try it. The problem is just a little bit different. The stove is down and out of service and although it was 140 F when the first pictures were taken in the stove, people could still get in and work on it, and the way we have attacked open hearth checkers has been during operation.

William J. Scharfenaker: Have you actually done some jobs where you deliberately searched and compared water alone and water with chemicals to see just how much the chemical adds to the job done by the high pressure water?

A. David Nesbitt: Yes, we have.

William J. Scharfenaker: What were the results?

A. David Nesbitt: I understand that those who observed the results felt there was a difference. The difference, if any, is not great. That difference is based on visual observation rather than on measurements or data. Maybe the observers had rose colored glasses. But laboratory observations, as mentioned before, do indicate the chemicals have some favorable effect. So chemicals have been used, but in amounts which do not represent a large fraction of the overall cost of the service.

William J. Scharfenaker: I have not seen one open hearth furnace that your equipment has been used on.

H. F. Lesso: In the checker cleaning work which has been done to date, have there been any residual chemical films found on the surfaces of the cleaned refractory which could result in premature glazing, thereby adversely influencing the heat radiation characteristics of the refractory?

A. David Nesbitt: I do not know.

H. F. Lesso: The reason for the inquiry is that in some refractories, there may be some residual constituent which would be reactive at elevated temperatures with the cleaning reagent residuals.

A. David Nesbitt: That could be a possibility.

R. S. Moore: I was very much interested in your thorough presentation and wonder if the nature of the solvents used is such that they go after both organic and inorganic deposits. Specifically with regard to the blast furnace stove, I was thinking of the load tests and the pyrometric cone equivalents determinations made in the laboratory.

I wondered if your tests were made on clean, unused brick, which were first saturated with the solution and then, when tested at high temperatures, were found not to have deteriorated as a reult of the saturation.

A. David Nesbitt: Apparently not.

R. S. Moore: The tests were made on clean brick?

A. David Nesbitt: I believe so.

R. S. Moore: I would just like to suggest that perhaps some consideration might be given in your further investigations to the testing of used blast furnace stove brick, specifically brick with a considerable deposit built up on them. Such deposits are often high in alkalies and the results of such tests might be somewhat different from those on clean brick. In other words, the solvent might take alkalies into solution and deposit them in the pores of the brick and thus have a considerable effect on the ultimate refractoriness of the brick. This does not discount the merits of your methods, but is merely a suggestion for further investigation along these interesting lines.

A. David Nesbitt: The only thing that I might say there is that many stoves have been cleaned with solvents repeatedly over the years; there are not too many stoves, but there are instances where repeated work on the same stove has taken place. No adverse effect has been noted in these cases. Probably you have noticed in the pictures that were shown that the brick was not too good in the first place on top of those checkers.

Warren Hart: Is there any evidence to support the idea that keeping plate coils clean will prolong the life of the furnace and reduce breakouts?

A. David Nesbitt: Probably not. There are some papers presented in the last year describing the correlation between furnace wall thickness and heat liberated at that point, and there is a definite correlation between the actual thickness of the furnace wall and the heat pick up. The only thing we might say there is that it would be rather obvious if the cooling system were operating at its maximum. You would be getting maximum cooling of your refractory and protection of it. Actually, the operator's problem is to get from one campaign to another or to get through one campaign, which may be four to six years or so and then, determine by inspection how much farther he can go or whether he should change hearth staves then.

Member: You are speaking of high pressure in cleaning your open hearth. Will you state what those pressures are and what range?

A. David Nesbitt: In general we are talking of pump pressures. However, where the lines have been adequately sized and we were close enough to the furnace, they might go as high as 2000 psi.

Now, I know in one that I observed myself, with the type of nozzles that we were using, much over a thousand pounds tended to cut the brick. The efficiency of your nozzle would have a lot to do with your pressure.

Member: Do you know what ranges of nozzle pressure they tried to operate at in the fifty-two jobs?

A. David Nesbitt: About 2000 psi, according to Dr. Louck who is close to all our problems.

William J. Scharfenaker: We are using currently and regularly high pressure water on our checkers. Our equipment, pump and so forth, is all designed to handle 1000 psi. We are actually working around 650 psi at the most. We have found that pressures above 650 do not do any more for us than what we get at 650. So, why run it at the higher pressures. It is tougher to run the machines, equipment; hazards and dangers are greater.

A. David Nesbitt: I think the nozzle efficiency enters into the picture somewhere there in determining the actual discharge pressure. Some nozzles are not very good and others are. We are trying to get maximum energy to the deposits with minimum cooling and tend toward smaller more efficient nozzles.

Charles Rich: How did you arrive at the depth that you stopped when you turned out the checkers in your stoves?

A. David Nesbitt: That is a good question, and this is a poor way to start to answer it, too. Both of the other stoves that the plant had to operate on were not any good either. So the problem was maximum speed. So the digging was done as fast as possible to a point where you could stand on the brick and it would not fall apart, and even in that case, it was not exactly true. If there had been more time available, I think more checkers would have been taken off and replaced.

Charles Rich: Were you actually in the stove that this was done on?

A. David Nesbitt: Yes, sir.

Charles Rich: Could a rod be used to run through the checkers at the point where you started to saturate.

A. David Nesbitt: On the typical area that was described, every hole was plugged at the surface or plugged six or eight inches down, or maybe at the most, a foot and a half. The last two courses of brick were carefully laid on a tarpaulin as they were taken off to avoid further plugging as the final brick were removed. We have to assume that this is the condition that was actually there. It is pretty hard to be careful while you are doing this kind of work, but I think that maximum care was exercised.

Charles Rich: My only reason in asking that was that figuring that you probably tore down the brick that had been fused or more or less had been really deteriorated and not worth saving, maybe the crustation that shows there was not a complete solid.

A. David Nesbitt: It was porous, I think is what you are trying to say. However, on the next stove that was done, rodding was undertaken to see what would happen. In no case were there any holes opened and the job actually was further complicated by having the stuff really packed in there. It just did not seem to be possible to rod them open.

Charles Rich: Did the time that you gave include the rebuilding of the checkers and the stove being back on blast?

A. David Nesbitt: The checkers were not rebuilt since the furnace was scheduled for relining at a reasonable time in the future. The ten days was total time off blast. All operations were completed during this time. Incidentally, within three days subsequent to its return to service, it was liberating about two and a half times the Btu's to blast that it had been liberating about two or three days before it was taken off.

William J. Scharfenaker: There was another reason to stop where we did, not a scientific one but a good one. We did not have any spares to put back in.

J. C. Anderson: I would like to know how you apply either your hydraulic or your solvent method to cleaning either the inside or the outside of a large tank.

A. David Nesbitt: I keep going back to the fact that each job is an individual one. It is possible to take a tank from extremely dirty service and clean it up for extremely clean service.

By illustration, let us take an extremely rusty tank which you might want to put into water-white alcohol service. That could be done with a minimum of time by combining high pressure jet streams with detergent alkaline materials and that procedure followed with the application of a thickened chemical solvent. In other words, the walls are covered with jelly material, and it is merely a matter of wiping it off to see how you are doing and smearing it back on.

Now, each application will do so much. The condition will dictate how many applications might be necessary. But you can take a pretty nasty condition and make a beautifully clean tank out of it for almost any service.

Subsequent to this type of a procedure with an extremely clean, active metal that you have at this point, you can also apply an after treatment which we have found has been very effective in preventing rust both on the outside or the inside of the tank which is ideal, of course, for a base in painting.

To illustrate the effectiveness of this material, a piece of metal that has been treated with it was thrown out in the yard and shows no evidence of rust in three weeks, in this kind of weather.

Robert Cleveland: You mentioned the hazard present from reactions of your cleaning solution. Do you have any more information on what protection you afford in this operation?

A. David Nesbitt: Many times it is in combination of our precautions with our customers' measures. As you know in the case of this stove, for instance, on an operating blast furnace, you had the constant gas hazard. It was felt that automatic carbon monoxide alarms should be in constant operation and actually, two of them were used, one to check the other. In addition to that, carbon monoxide testers were used every ten minutes during the whole time that men were in the stove. Gas masks were available for all personnel that were in the hazard area for instant use. It would depend, for instance, on whether your atmosphere was such that it had enough oxygen to sustain life or whether it did not, whether you would use a canister mask or a self-contained oxygen mask. There, again, each problem is pretty much different. Safety is of prime importance in all ventures, but of particular importance in many blast furnace and steel plant situations because of the constant hazards present. Thoroughly experienced, trained service personnel are of particular importance in recognizing and combating these and other ever present hazards.

A. Donald Shattuck: In preparing to do a job in our plant, do you need a storage area or office space?

A. David Nesbitt: We do not generally consider that, but the steel plant operator, in using outside contractors, generally has to provide offices and storage areas for tools and sometimes many other facilities.

In our particular case, all our equipment is mobile and can be moved completely, generally in a matter of a half hour. The jobs which we undertake very seldom last more than two days—sometimes four or five, in an extreme case such as the stove. But the equipment is portable and easily moved to almost any location. No sheds, no headquarters are necessary.

STATISTICAL EVALUATION OF OPEN HEARTH PRODUCTION FACTORS

By E. J. SOBEY and R. E. MINTO*

▲ IT has long been recognized that the criteria for evaluating the relative efficacy of hot metal in the open hearth process leave something to be desired.

Since it is not possible by any simple method to deal solely with one isolated, influencing, production factor, a good way to start is to list all the possible factors that might influence the one variable you wish to study and then eliminate the effect of each of the others in turn by selection of data or statistical methods. In this study we wished to evaluate the effect of hot metal temperature on open hearth production rate; so we listed it and all other factors and proceeded by selection and the statistical method known as multiple correlation.

Seventeen factors were considered as having an important influence on heat time.

On due reflection and study of these seventeen factors, it was decided that all except five could be eliminated or neutralized by selection. Two of these five, silicon content and amount of hot metal, were combined and the product was used as one variable. Therefore, the four variables in the multiple correlation portion of the study were:

1. Hot-metal temperature.
2. Time required to charge scrap.
3. The product percentage of silicon in hot metal times the amount of hot metal.
4. Amount of ore or hot-metal additions required.

The qualifications used in selecting the 120 heats for study were:

1. 0.08/00 carbon rimmed heats.
2. Heats from furnaces of 175 tons capacity.
3. Heats with 53 per cent hot metal.
4. Flush heats (125 lb per ton charge ore).
5. No previous bottom delay over 30 minutes, no delays during heat.
6. Constant limestone charge (about 6.5 per cent).

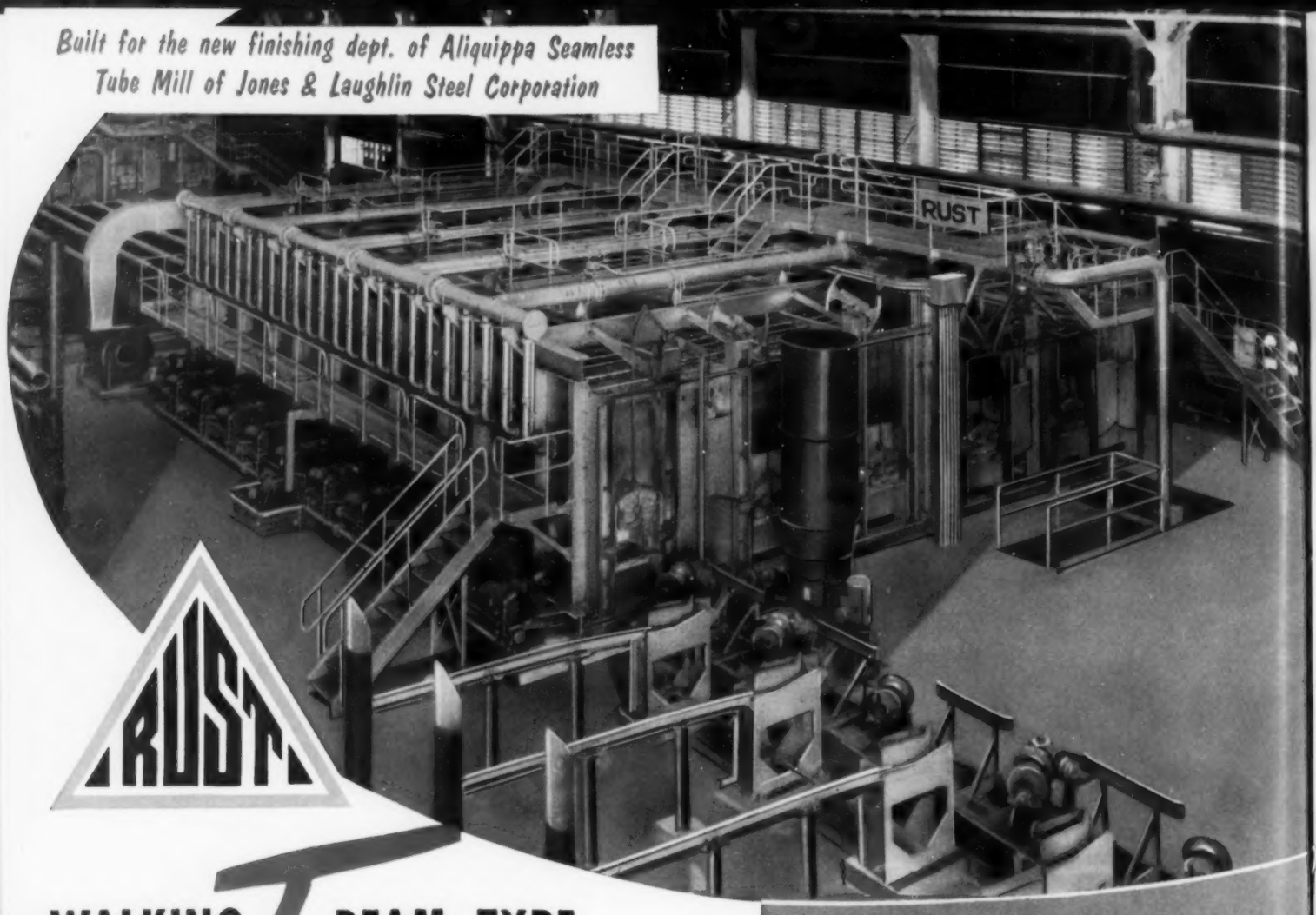
A few precautions concerning the interpretation of results should be mentioned. In all cases, the deductions drawn can apply only to the range studied and the particular set of conditions assumed. It would not be good practice, for instance, to use the present data to predict what might occur above or below the range of data considered, nor does it follow that data that are linear in the studied range would remain linear if extended.

In summary, the statistical method was used to study four important factors affecting open hearth production rate. The final curves explained the effect of individual factors in a more logical manner than did uncorrected graphs; and the value of the statistical method became apparent. As was expected, hotter hot metal, minimum time to charge scrap, optimum total silicon charged, and minimum additions favored an increased production rate. The magnitude of these influences is on the order of:

1. 0.5 tons per hour per 100 Fahrenheit degrees for hot metal in the temperature range 2220 F to 2440 F.
2. 0.3 tons per hour per hour in time to charge scrap.
3. Minimum deviation in silicon content is more important than silicon level within an acceptable range.
4. 0.3 tons per hour per 5000-lb ore addition or 22,000-lb hot-metal drink requirement.

*Assistant Open Hearth Superintendent and Chief Metallurgist respectively, Jones & Laughlin Steel Corp., Cleveland, Ohio. Abstract from paper presented at Blast Furnace, Coke Oven, and Raw Materials Conference, Philadelphia, Pa., April 19, 1955.

Built for the new finishing dept. of Aliquippa Seamless Tube Mill of Jones & Laughlin Steel Corporation



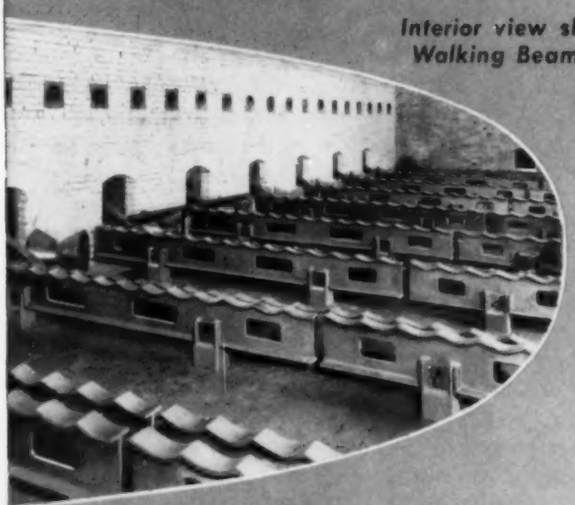
RUST

WALKING BEAM TYPE HEAT TREATING *Furnaces*

For heat treating their seamless tubing, the Jones & Laughlin Steel Corporation chose two specially-designed Rust furnaces as shown above. These walking beam type furnaces were designed and constructed by Rust in record breaking time—and they are helping the new "J & L" Seamless Tube Finishing Department to break records in producing, conditioning, and finishing high tensile strength seamless tubes.

Be sure to consult Rust on any problem of tube and pipe annealing, heat treating, and processing. Rust also designs and builds other type furnaces to meet every metallurgical heating need.

Interior view showing Walking Beam Rails



FIRST *installation of this type for Normalizing, Quenching and Drawing of Seamless Tubes*

*Walking Beam Rails designed and furnished by York-Gillespie Mfg. Co.

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COIL CONVEYORS at U.S.I.N.O.R's Hot Strip Mill

▲ THE need for hot and cold strip mills in France had been apparent for many years. However, World War II disrupted normal industrial growth, and it was not until 1951 that the first continuous hot strip mill was put into operation at Denain, about 150 miles north of Paris.

Planning for this project started in 1945 when the possible sites were studied and recommendations were made on layout and size of equipment. At the same time, a cold strip mill was being planned to handle the output from Denain, and to distribute the final product. This mill has since been built at Montataire, about 40 miles north of Paris. It started operations in 1950.

Both of these mills were engineered and constructed by the United Engineering and Foundry Co. of Pittsburgh, which also furnished most of the heavy equipment.

From the first, an important question was, "Who is going to finance the building of these two mills?" The answer came in 1948 when the two main metallurgical firms in Northern France — Hauts-Fourneaux, Forges & Aciéries de Denain et d'Anzin and Forges & Aciéries du Nord et de l'Est —merged to form a new company, U.S.I.N.O.R. (Metallurgical Union of the North of France). This merger marked a new era of expansion and modernization for the French steel industry.

The new company employs about 15,000 people and, at present, produces around 1,700,000 tons of steel per year, or 15 per cent of the total French output. It controls a number of plants, all in the northern part of France.

One of the first projects for U.S.I.N.O.R. was to erect the hot mill at Denain. Among other things, this involved obtaining permission from the government to purchase a large quantity of equipment (over 16,500 tons) from firms in the United States.

Before the industrial revolution, Denain was a rich agricultural and forest land. In 1713 it was the site of a crucial battle which led to the end of the war of the Spanish Succession. Today, it is a typical town in what has become known as the industrial "Black Country" of France, with its mills, coal mines and clusters of miner's cottages.

An abundant supply of bituminous coal, navigable waterways and good railroad facilities have naturally drawn much heavy industry to the area. Most of the U.S.I.N.O.R. facilities are in the general region,

Figure 1 — Downtilters remove hot coils of strip steel from the coilers and deposit them directly onto a conveying system at the Denain Mill of U.S.I.N.O.R., Denain, France, the first hot strip mill to be built in that country. The whole system includes about 600 ft of conveyor, two lift-and-turn transfers and scales to weigh the coils as they are handled to storage.

Figure 2 — Two conveyors (right) bring the coils from two downtilters to these lift-and-turn transfers, where the direction of travel is changed 90 deg. The coils are deposited onto the two inclined conveyors (background) for delivery to the storage area. Between 500 and 550 coils are handled on this system in each 18-hr work day.

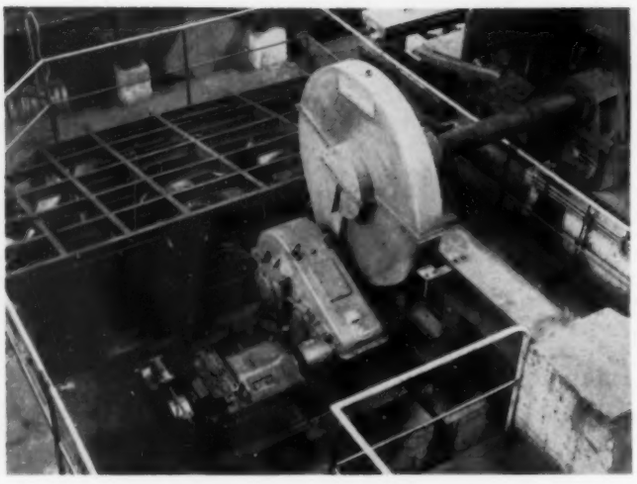

Figure 3 — (left) Drive on one flat-top roller chain coil conveyor consists of a 25-hp motor through a parallel shaft gear drive and cut-tooth gears. The companion conveyor has a similar drive, while two longer inclined conveyors are each driven by a 50-hp motor. All four conveyors have a speed of 18 fpm.

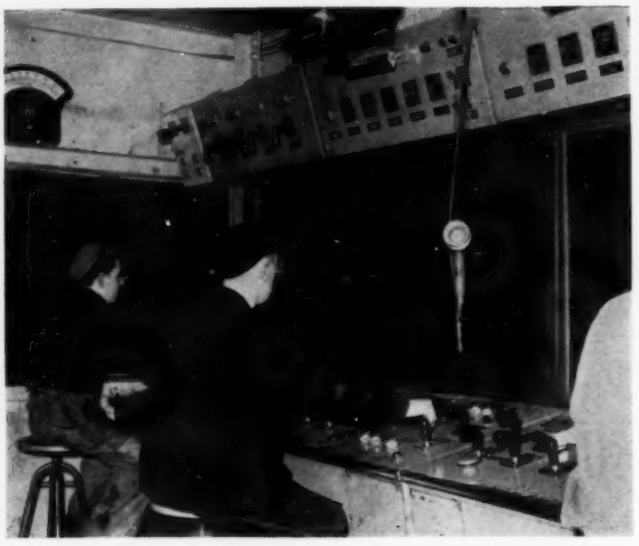

Figure 4 — (right) Operation of the conveying system at Denain can be either automatically controlled or manually operated from three central control stations, one at downtilters, one at the lift-and-turn transfers (seen here) and one at the scales.

and one of its steel plants, with a yearly production of about 1,100,000 tons of ingots, is located adjacent to the new hot strip mill.

Denain-Anzin (one of the two companies that merged to form U.S.I.N.-O.R.) built the first iron works in northern France in 1834. By 1914 the firm had grown quite large, but World War I saw most of its facilities completely destroyed. In a rebuilding program, Denain-Anzin emphasized production of flat rolled products, and it soon became a leader in this field in France. It is quite natural that this company should be associated with the building of the first hot strip mill in France.

The hot mill at Denain is designed for the continuous rolling of strip, either in coils or sheet, and light plate at a rate of one to two million tons per year. This mill has 19.3 sq miles of space devoted to equipment, which includes soaking pits, a slabbing mill and shear, a slab continuous yard, the continuous hot mill with 10-roll stands and two scalebreakers, a flying shear, two coilers and a flat sheet piler and finishing and pickling facilities.

United Engineering and Foundry Co. placed an order with Link-Belt Co. to design and furnish a conveyor system to handle hot coils from the two coilers to the storage area. This installation consists of four Link-Belt flat top, multiple-strand roller chain coil conveyors with a total length of almost 600 ft, and two lift-and-turn transfers.

United downtilters at each of the two coilers discharge red hot coils directly onto a conveyor. These two conveyors are parallel and extend for a distance of 130 and 117 ft respectively to the two turn-and-transfer stations. Here, two other parallel conveyors—one 200 and the other 150 ft long—receive the coils from the lift-and-turn mechanisms and deliver them to the storage area. These conveyors are inclined about six degrees.

The coils cool as they are conveyed, so that when they are unloaded in the storage area by an overhead crane, there is no danger of scuffing. The cooling function was considered when designing the conveying system. Each coil is supported by the chain in a way that permits the air to circulate freely around the coil and beneath it, thus facilitating the cooling.

During an average 18 hour work day the conveying system handles between 500 and 550 coils with a total weight of about 2,000 long tons. The average coil being handled now weighs between 6,000 to 10,000 lb, and all are extremely hot. But the conveyors were designed to carry coils weighing up to 25,000 lb, the maximum size that can be handled in the mill.

Link-Belt designed an unusually sturdy chain for use on these conveyors. It has an ultimate strength of 340,000 lb, and 18-in. pitch, and is supported by 5-in. diameter cold roll steel idlers which are equipped with roller bearings.

The pins are 2⅜ in. diameter and are necked for the bearings of the outboard rollers. Each pin is drilled and cross-drilled in order to lubricate both the rollers and the chain sidebars as they articulate around the chain pins. Despite the constant exposure to severe heat radiation, the chains are still going strong after three and one-half years.

Each of the two conveyors from the coilers to the turn-and-transfer stations has a drive which includes a 25-hp d-c motor through a Link-Belt T-130 parallel shaft gear drive and a cut-tooth gear drive. The two conveyors to storage are each driven by a 50-hp d-c motor through a Link-Belt T-200 parallel shaft drive and a cut-tooth gear drive. All four conveyors move at a speed of 18 fpm.

The coil conveying system at Denain is operated intermittently. It can be automatically controlled, or manually operated from three central control stations, one at the downtilters, one at the lift-and-turn transfer station, and one at the scales where the coils are weighed en route to storage.

The hot strip mill at Denain, including the conveyors, is being operated 24 hours a day, with one 8-hr shift devoted to maintenance only.

Link-Belt power transmission equipment, transfer chains and other miscellaneous parts were furnished through United for use in other sections of the mills.

THE WALL STREET JOURNAL.
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NEW YORK, WEDNESDAY, FEBRUARY 23, 1955

New Wrinkles

Refractory of Chrome Ore, Magnesite Claimed To Aid Steel Makers

Special to THE WALL STREET JOURNAL

LOUISVILLE, KY.—Steel and glass both must have heat—several thousand degrees of it—when they're being made.

Corhart Refractories Co., a subsidiary of Corning Glass Works, is finding this common factor a business booster. Started in 1927 to supply the glass industry, Corhart is branching out into the steel industry with its special Corhart 104 refractory. It is made of magnesite and chrome ore.

A refractory is basically a material that doesn't melt easily. Refractory bricks are used to line glass and steel furnaces. At present, the steel industry uses about 60% of all refractory materials produced.

"This new refractory has really caught on in the steel industry," declares Hugh L. Kline, vice president and general manager of Corhart. By putting Corhart 104 in the hottest parts of an electric furnace wall, one steel firm boosted the furnace's steel output by 37% before the wall had to be replaced, he says.

The only disadvantage of Corhart 104, Mr. Kline says, is its price of about $350 a ton—roughly three and a half times the cost of the basic furnace brick now used by steel makers. However, he says, "it only takes a little figuring to show that the new brick saves money by cutting operating costs and increasing furnace production."

In electric furnaces, only the "hot spots" are lined with Corhart 104, Mr. Kline says. The remaining 90% of the wall has conventional brick. The whole furnace lasts longer, yields more steel and is out of service for relining a shorter time, he claims. About five tons of Corhart are used in an electric furnace, where temperatures are around 3,000 degrees Fahrenheit.

Electric furnaces are used mostly to produce special steels. Corhart is not overlooking open hearth furnaces, which account for about 92% of total steel output. Tests were started in January on the roof of an open hearth furnace. To fortify the hottest parts of an open hearth roof requires about 15 to 20 tons of Corhart, Mr. Kline says. A typical furnace roof now has to be replaced in about 12 weeks, he notes. Mr. Kline believes his new product will extend this period long enough to give Corhart another market.

Let us send you full technical information. Suggested applications and estimates of costs will be included if you will describe your operations. Corhart Refractories Co., *Incorporated,* 1632 West Lee Street, Louisville 10, Kentucky, U.S.A.

QUALITY ECONOMY ENDURANCE

CORHART 104
ELECTROCAST
REFRACTORY

The words "CORHART" and "ELECTROCAST" are registered Trade Marks which indicate manufacture by Corhart Refractories Company, *Incorporated*

Automatic Welding Process Uses Carbon Dioxide Gas

▲ A new, automatic welding process known as *C-Omatic*, which uses low-cost carbon dioxide gas for shielding the arc while welding mild and medium carbon steel, has been developed by the A. O. Smith Corp. of Milwaukee, Wisc.

Similar in operation to the shielded inert-gas metal-arc process known as *sigma* or *aircomatic* welding, the new A. O. Smith development was initiated because commercially available automatic welding heads used with argon or helium gases were limited in application, due mainly to the high cost of shielding gases, particularly on fabrication of carbon steel products.

The *C-Omatic* process offers the advantage of low-cost automatic welding plus the benefit of a visible arc, which enables the welder to properly locate the arc in the welding groove and observe the weld metal being deposited.

Illustrating the economies effected with the use of carbon dioxide in welding are figures compiled on comparative costs of various inert shielding gases per cu ft along with comparative gas consumptions of various shielding gases per hour.

Bases on the use of standard size cylinders, the cost of carbon dioxide is approximately 0.01 per cu ft, as compared with 0.06 per cu ft for helium and 0.08 to 0.09 per cu ft for argon. When large quantities of gas are used, the gas cost may be less, since carbon dioxide can be obtained in liquid form, stored in a large container, converted to gas and piped to the welding equipment for as little as one-half cent per cu ft.

Equally impressive cost savings can be obtained in gas consumption through the use of carbon dioxide. Tests have shown that the quantity of carbon dioxide gas required is approximately half of that needed when helium or argon are used. X-ray quality welds can be obtained with the C-Omatic process, using 30 cu ft (or less) of carbon dioxide per hour, while 60 cu ft of argon, and 70 cu ft of helium are required for the same purpose.

Comparative costs of carbon dioxide, argon and helium again show that tremendous savings can be gained through the use of the new process. Based on a 260-day work year, on a three-shift operation, 60 per cent duty cycle, cost of carbon dioxide would be $1053 compared with $16,420 annually for helium. This represents a saving of $15,367 per welding head annually. It is again stressed that the carbon dioxide figure can be brought even lower in quantity use.

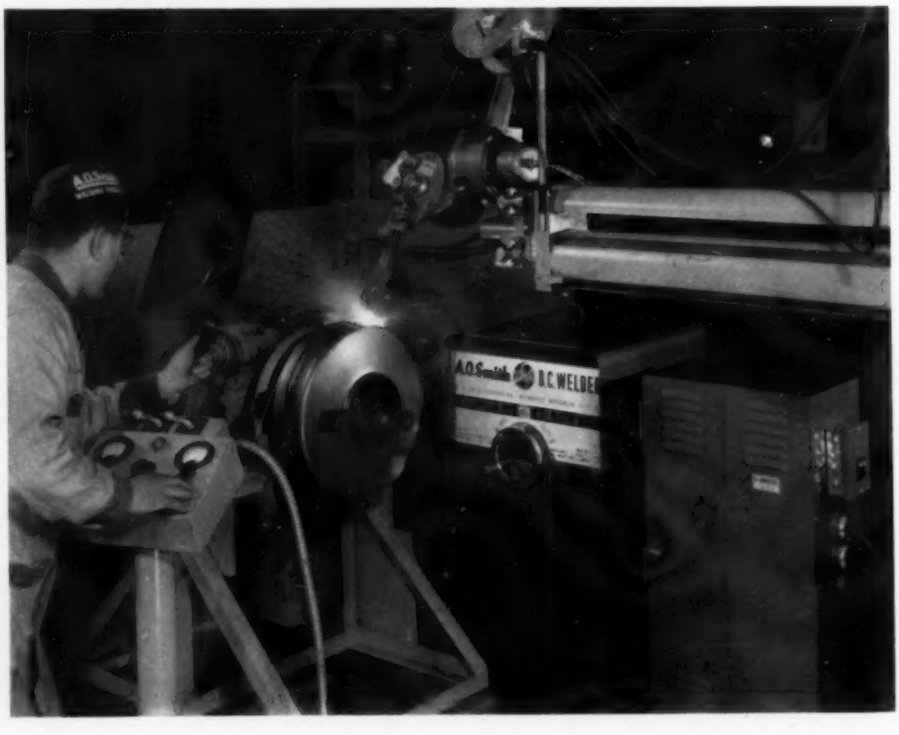
Using the same figures, cost per hour of welding with carbon dioxide is $0.30 per hour compared with $4.20 per hour using helium.

Comparing carbon dioxide costs with argon, tests have shown that carbon dioxide will cost $0.30 per hr, compared with $4.80 for argon. On the same three-shift, 260-work-day year, the figures would be $878 for carbon dioxide as compared with $15,780 annually for argon, or a saving of $14,902 per year per welding head.

Other features of the new welding process, excluding the important cost factor, include the fact that with a visible arc, there is no need for flux and the attendant cleanup time that is required.

Welds made with carbon dioxide gas have a wide and well rounded bead penetration. The shape of bead penetration obtained with carbon dioxide gas offers an advantage in some applications, such as in the case of a "V" groove joint. A round bead

Figure 1 — The operator is demonstrating how the automatic welding head of the new C-Omatic gas-shielded metal arc process is remotely controlled from panel. A single C-Omatic unit can save up to $15,000 a year on the cost of gas alone, compared to other shielded arc processes.



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GRADES N-2 and N-6, first brushes specifically designed to resist silicone vapors at elevated temperatures, handle a wide range of commutation requirements. Originally formulated for a special military application, results were so favorable that these new grades are now part of the complete "National" brush line.

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penetration insures complete fusion and provides better liberation of gases from the molten puddle.

The C-Omatic welding head is a simple, rugged unit. Filler wire of special formulation is fed to the head by means of rollers, with a dependable motor drive giving easy selection of wire feed speeds. This wide variance in wire speeds permits application to submerged arc welding, a conversion that can be made by substituting a submerged arc nozzle and making a few minor electrical connections. The head can be easily adjusted for welding in any position.

The nozzle on the welding head is also of simple, rugged design and consists primarily of a contact tube, water cooled jacket and a gas-shielding jacket. All major metal parts are brazed together so that no "O" rings are required, thus eliminating the major cause of leaks in this type of nozzle. The nozzle is designed to provide a shield of gas around the wire the full length of the contact tube, minimizing the tendency to draw air into the arc. The contact is sufficiently long to provide good electrical contact, and is easy to remove.

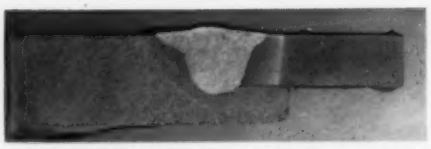

Figure 2 — Weld made with CO_2 gas for shielding.

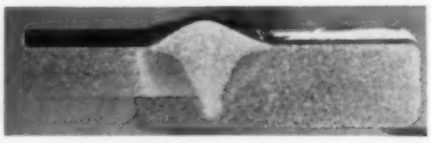

Figure 3 — Weld made with argon gas for shielding.

The control system is electrical-mechanical in design. Simply constructed for easy service and low maintenance cost, the system is of the constant current type and maintains a pre-set arc voltage. In its operation, the arc height is proportional to the arc amperage. The control system can be supplemented by auxiliary controls to assure a fully automatic welding operation.

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Summarizing, carbon dioxide has five distinct advantages over other forms of gas for welding.

First, it has been illustrated that carbon dioxide provides a low-cost method of welding which, for the first time, makes possible the use of automatic equipment on mild and medium carbon steels. Then, too, visibility of the arc at all times assures positive control of the welding operation, leaving nothing to "guesswork."

The cleanliness of the weld, a vital factor in plant maintenance, eliminates slag removal and resultant slag entrapment in the weld.

Another advantage of the carbon dioxide process is that it eliminates abrasive powdered flux in the area of the welding operation, thus averting another cleanup operation, and saving time and manhours that can be more profitably spent.

Finally, deep penetration and high metal deposits form a distinct advantage for single-pass welding as used in the C-Omatic process.

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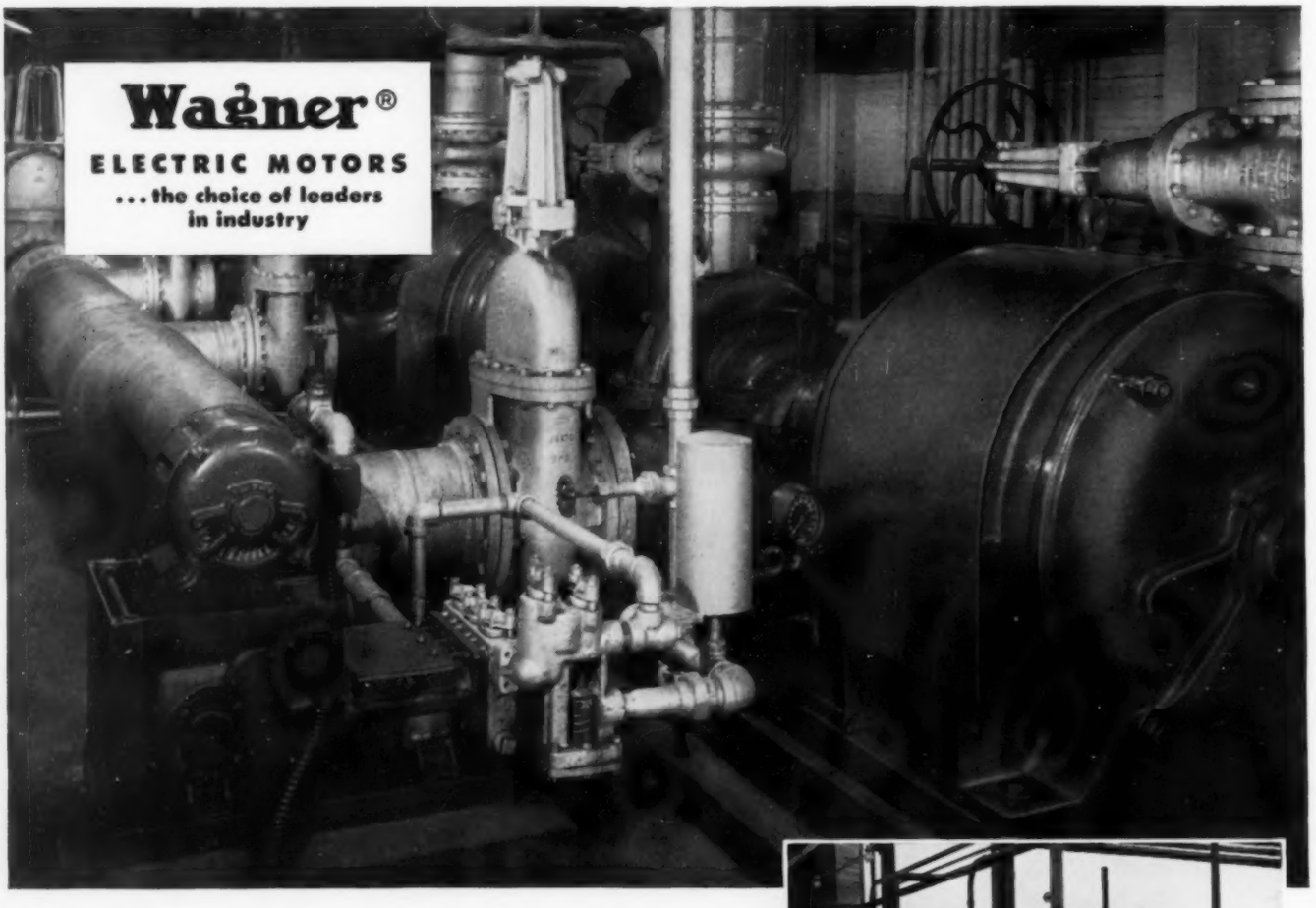

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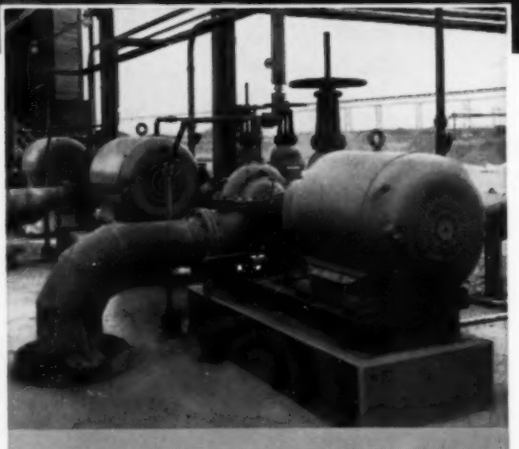

A 60 hp, type CP-1 and two 100 horsepower, type EP-1 Wagner motors driving final cooler pumps in the coal chemical area at Fairless Works coke ovens.

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ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS–AIR AND HYDRAULIC

New Method Expands Slag for Aggregate Use

By S. P. KINNEY
President
S. P. Kinney Engineers, Inc.
Carnegie, Pa.

▲ BLAST furnace aggregate should have five major characteristics: light weight, high compressive strength, proper size gradation, be sufficiently dry for economical transportation and efficient mixing, and free from objectionable coloration. All these requisites are easily met with the recent development of an entirely new process for the expansion of slag.

Known as the Kinney-Osborne process, this new method expands slag for use as a light weight aggregate. Basically, the process consists of the use of a combination of steam, air and water; steam and air for the motive force, and steam and water for contacting and expanding the slag. No machine is used and there are no mechanical or moving parts to wear. The slag is treated at the end of the cinder runner direct from the monkey or slag ladle. As the slag enters a chute connected to the opening of a small blow chamber, it encounters a blast, from a large nozzle of steam or low pressure air, and with certain types of slag, a small amount of water. This blast disintegrates the slag into numerous small globules but does not complete the expansion. These globules immediately encounter water in the form of a very fine spray, or mist, from a number of small nozzles located in a semi-circle. Each nozzle has both water and air jets. The air is used for atomizing the water. This fine atomized water contacts the small globules of slag and completes the expansion. The expanded globules reagglomerate to form a clinker.

The semi-cooled clinker and expanded slag from the blow chamber is then transmitted directly to an elevated bin by means of a drag conveyor. From this point, it is discharged to a double roll crusher that is set to produce a sized aggregate. The aggregate then passes down through a double deck screen and is subsequently discharged in a dry and granular form into railroad cars or trucks. The slag may be discharged directly from the conveyor in clinker form for further processing at a processing plant remotely located from the furnace site. Figure 1 shows a recent installation at a blast furnace plant, and Figure 2 an installation at Birmingham, Alabama, showing the drag conveyor, elevated bin, roll crusher and screens.

Adaptability to various furnace slags — The ease of control, along with the wide latitude in mixtures of air, water and steam, makes this process easily adaptable to the wide range in com-

Figure 1 — General view of slag plant shows expanding chamber and stack.

Figure 2 — Drag conveyor is used to transport the slag to the roll crusher and screens.

TABLE I

Chemical Analysis of Blast Furnace Slags, Per Cent
Southern Practice (Southern Ores)

Plant	A				B			
Furnaces	1	2	3	4	1	2	3	4
SiO_2	38.64	37.26	38.04	38.04	35.96	36.90	34.28	35.60
Al_2O_3	13.86	14.84	14.40	12.61	11.88	12.29	12.24	14.65
FeO	0.65	0.65	0.65	0.18	0.52	0.39	0.52	0.16
CaO	43.76	43.51	43.36	44.54	41.94	38.26	42.41	40.87
MgO	1.96	2.32	2.18	2.06	8.51	10.66	9.30	7.42
Sulphur	1.26	1.28	1.26	1.07	1.60	1.95	1.78	0.92
MnO	0.30	0.58	0.54	0.54	0.39	0.52	0.36	0.36

Northern Practice (Mesabi Ores)

Plant	A	B			C	D
Furnace	1	1	2	3	1	1
SiO_2	36.00	42.20	38.54	35.78	39.20	35.98
Al_2O_3	11.00	7.51	8.14	8.77	10.00	9.76
FeO	0.50	0.39	0.26	0.39	0.33	—
CaO	41.00	42.05	45.90	48.65	44.54	43.98
MgO	8.00	4.65	4.66	4.63	5.10	6.93
Sulphur	2.00	1.14	1.11	1.09	1.28	1.71
MnO	1.00	1.89	1.08	0.65	0.72	—

TABLE II

Blast Furnace Slags Suitable for Cement (Chemical Analysis), Per Cent

Plant	A		B		C	
Furnace	1	2	1	2	1	2
SiO_2	29.90	29.7	32.00	32.3	32.40	32.1
Al_2O_3	18.93	18.6	18.57	19.06	19.61	20.0
FeO	0.21	0.64	0.19	1.03	0.27	0.64
CaO	40.97	40.1	39.48	37.2	37.69	35.9
MgO	7.28	7.26	7.17	7.2	7.93	8.54
Sulphur	1.62	1.79	1.49	1.70	1.49	1.39
MnO	0.62	0.57	1.07	1.05	0.90	0.95

position and temperature of furnace slags found in the industry. The simple nozzle arrangement is very flexible. These nozzles may be varied at will, and adapted to the physical properties of the slag being produced at the time. The nozzles are generally set before the flush or cast period and not changed from day to day. The operator simply turns on the master air, water, and steam valves before the flush or cast slag flow starts. Any slag which is produced in the making of pig iron is susceptible to treatment.

With this new process the chemical composition of the slag is not critical, as slags containing from 2 to 12 per cent magnesia have expanded equally as well. The process has also been tested on ferro-manganese and other various slags. These slags have expanded well.

Typical slags used in the Kinney-Osborne process — From iron slag, this process will make a uniform product both as to chemical composition and as to size. In Table I will be found a number of blast furnace slags which have been expanded by this process in various plants in the northern and southern sections of the United States:

Slags listed in Table I are all suitable for making cement. In addition to these, Table II gives other blast furnace slags which have been tested and which will make a high quality cement:

Composition of the aggregate — The expanded slag made by this process has great strength. When incorporated into concrete blocks, the material will conform with building and construction codes. The degree of expansion is controlled by the setting of the various jets and nozzles. When hit by the streams of fluid, the molten slag expands just enough so that the pores throughout the mass are open with the cell walls remaining strong. Figure 3 shows this slag after expansion. The cell walls are very substantial so that when the slag is crushed to size for the manufacture of concrete blocks or other slag products, it does not collapse.

With this new process, various water and steam jets are used to expand the slag to just the right degree. These jets of water and steam also help to cool the molten slag which then falls to the bottom of the blow chamber and forms into a porous gob of semi-molten substance. Further cooling takes place as the expanded slag is elevated from the blow chamber. By the time the slag reaches the elevated bin at the top of the drag conveyor, it is sufficiently cool for crushing and screening. The large pieces formed in the chamber and on the conveyor are still porous throughout.

Aggregate in cement — Light weight expanded slag is especially adaptable as a raw material in the manufacture of cement. There are special advantages in the use of this expanded material as compared with a wet pin granulated product. The molten slag from the furnace is expanded by the application of air, water, and steam, through the nozzles. The amount of water in the finished expanded light weight aggregate is controlled by the amount of water added in the nozzles.

Figure 3 — Slag produced by process has substantial cell walls.

In the manufacture of cement, it is desirable to keep coke out of the slag. In the Kinney-Osborne process, the coke is retained in the retention pit at the furnace and the light weight aggregate produced is free of coke.

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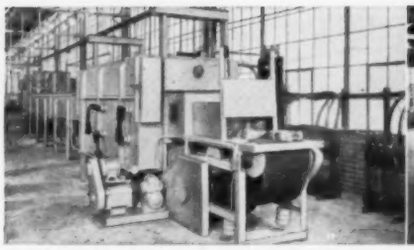
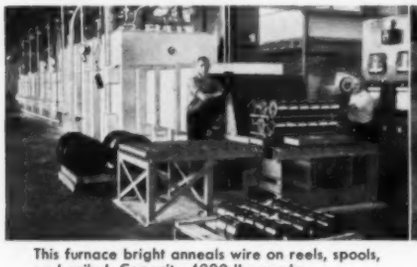


EF belt conveyor furnace bright annealing coiled alloy steel and non-ferrous wire.

EF continuous roller rail pusher furnace, bright anneals large reels and coils of wire.



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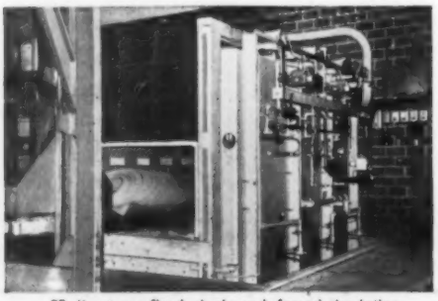
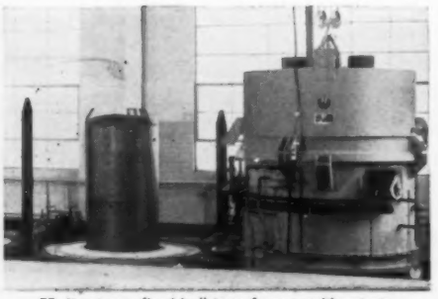
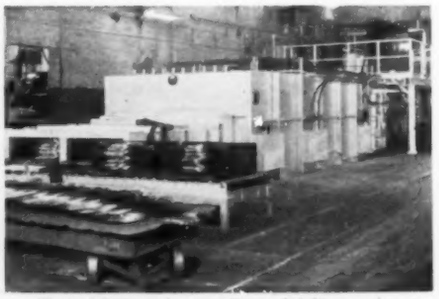


EF direct gas fired, single end, forced circulation hearth type annealing furnace with gantry crane for handling large coils of cupro nickel wire and brass rod.



EF direct gas fired bell type furnace with retorts and 4 forced circulation bases, used for bright annealing both ferrous and non-ferrous flat coiled wire.



EF special atmosphere continuous bright annealing furnace in which the wire is conveyed through the various zones on two parallel rows of bulkhead type trays.

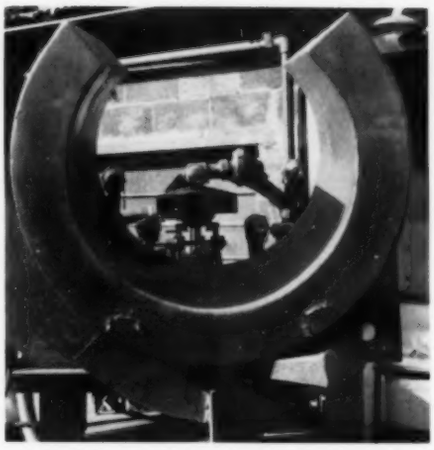


Figure 4 — Illustration shows spray apparatus which is used in the process.

After the cast or flush is completed, the retained coke is removed from the pit at the furnace.

Water pollution — In the production of light weight expanded slag for various products, including cement, only a small amount of water is employed. Some of this water goes up the stack in the form of steam and some of it is loaded out as moisture in the slag. There is no excess overflow of water to be removed to the sewer, thus eliminating any problem of stream pollution. No retention tank or thickener is required.

In the slag granulating operation at blast furnaces, the slag is first quenched with water, deposited into a large pit, and then picked up with an overhead crane, the problem of returning clarified water to the river is one which entails the use of a large amount of additional equipment. The use of this process provides a means of completely eliminating water pollution. This problem is becoming more and more important in industrial centers.

Location of the slag plant — The most practicable location of the slag plant is at the blast furnace site where the slag may be treated immediately upon being flushed from the furnace. The compactness of this equipment permits installation in less space than is now required by present granulating pits and in much less space than is needed for a hot slag bed. In some plants, where the furnaces face each other, the system may be arranged to serve two furnaces with the same expanding and conveyor equipment. This arrangement eliminates the use of cinder ladles and a great deal of switching.

Central station — In some cases a central station may be employed where ladles from a number of furnaces may be handled. Situating the slag plant in close proximity to the furnace permits the dry finished product to be loaded directly into railroad cars and shipped as soon as loaded. Consequently, a considerable credit accrues to the furnace operation as soon as the finished product is loaded and billed. There is no charge for removal of the slag. It is common knowledge that mills pay as high as $1.00 to $1.50 per ton for the removal of slag from the furnace to a distant slag dump.

If the immediate furnace area is too congested, the product from the small blow chamber may be lifted by an elevator and carried to a control screening station by belt or other means of conveyance. Cinder ladles may also be utilized to haul the molten slag to the expanding station.

Figure 5 — This plant is located at a southern blast furnace site. Air-cooled pits may be seen in the foreground.

INSTALLATIONS

There are a total of nine plants now using this new process. The amount of slag being expanded by each slag plant ranges from 500 to 1000 tons per day.

Results from actual operation, Birmingham, Alabama — There are six Kinney-Osborne installations in two different plants in the Birmingham area.

At one company, there are two installations which have been in operation for a long period of time. More recently, a third installation, incorporating the most recent developments in the process, has been constructed at this plant. Each blast furnace produces approximately 500 net tons of pig iron and about 400 tons of slag per day. Situated adjacent to the furnaces, the expanded slag plants process the entire flush slag production. A typical slag plant at one of these locations is shown in Figure 5. Actual time of operation is about 400 minutes, 28 per cent of the time, at a rate of 60 tons of slag per hour.

Utilities required — Utilities needed to produce 60 tons per hour, or one ton per minute, of the expanded product are given in Table III.

Operating crew — One man from the furnace crew, if there are more than two, can control the cinder flow and operate the expanding nozzles. This man's time can be charged to the blast furnace operation. Another man, charged to the operation of the slag plant, operates the car haul and checks the performance of the roll crusher and screens. Power for the crusher is supplied by a 40-hp motor. A 25-hp motor furnishes power for the drag conveyor, and a 7½-hp motor is used to operate the screens.

TABLE III

Utilities (One Ton Per Minute)

	Pressure, psi	Quantity
Steam	40	4000 to 5000 lb per hr
Air	50	150 cfm
Water	40	150 to 200 gpm

TABLE IV

Utilities Required

	Pressure, psi	Quantity
Steam	50	10,000 to 20,000 lb per hr
Air	50	300 to 650 cfm
Water	40	400 to 1000 gpm

Labor costs — Labor costs are at a minimum. Less men are needed to operate the Kinney-Osborne slag plant then any other method. The entire slag plant operation is carried on by two men. One man, the cinder snapper, or man who flushes the furnace, turns on the main valves (water, air, and steam) and then throws the switch to put the drag conveyor and screens into operation. The other man operates a car haul and spots the cars underneath the screens. A sufficient number of cars are kept on a siding

Figure 6 — General view of conveyor at slag plant in Cleveland area.

Figure 7 — Control panel for slag plant in Cleveland area.

and during flushing of the furnace, this man places these cars in position with a car haul. As the cars are loaded, they are then shifted down the track and the whole drag is pulled out later in the day. The operator of the slag plant is really one of the furnace crew and the operator of the car haul offsets having a crane operator over a wet slag granulating pit. This operation is cheaper than picking up hard slag from a pit with shovels or having a crane over the granulating pit.

Cleveland, Ohio — The newest and also the largest installation of the Kinney-Osborne Process has just been completed at the works of a large steel manufacturer in Cleveland, Ohio.

The slag plant is situated immediately adjacent to the blast furnace. The furnace produces approximately 1400 net tons of pig iron and about 1000 tons of slag per day. The slag plant has a rated capacity of 240 tons per hour. This installation is designed to expand the entire slag production of this particular furnace.

The utilities and the approximate amounts used to produce up to 240 tons of expanded product per hour are given in Table IV.

The flush slag flows directly from the furnace to a retention pit. A second retention pit is employed for the cast slag. There are four feed runners leading from the second slag retention pit to the expanding apparatus. The expanding equipment consists of four sets of air, water, and steam nozzles; one at the end of each runner. On flush, two sets of nozzles are used; and during cast, all four are used.

After expansion in the blow chamber, the slag drops onto a double drag conveyor where further cooling takes place as it is transported to the discharge chute approximately 100 ft from the expansion point. This conveyor is powered by a 75-hp motor and fluid coupling assembly.

From the discharge chute, the slag clinker empties into a slag pit, from where it is loaded into trucks by an overhead crane and removed offsite for crushing and screening.

The blow chamber is equipped with a 9 ft-6 in. inside diameter exhaust stack.

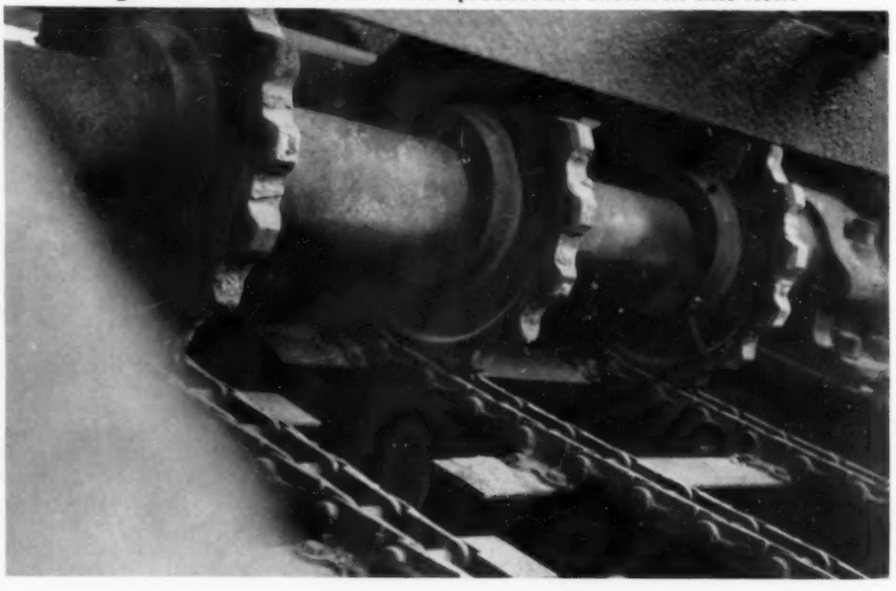
Views from this slag plant, are given in Figures 6, 7 and 8.

SUMMARY

The product derived from this new process has already had wide acceptance in the construction industry which is indicative of its uniformly excellent quality. The combination of economy, strength, lightness of weight, insulating qualities, and pleasing appearance of the items makes this expanded slag an important factor in the construction material field.

In addition to having a product able to meet the most rigid specifications that may be demanded by the trade, this new process has a definite economic advantage. The granulating forces used are ordinary utilities common to all plants and the quantities used are nominal.

Figure 8 — Details of chain and sprocket are shown in this view.



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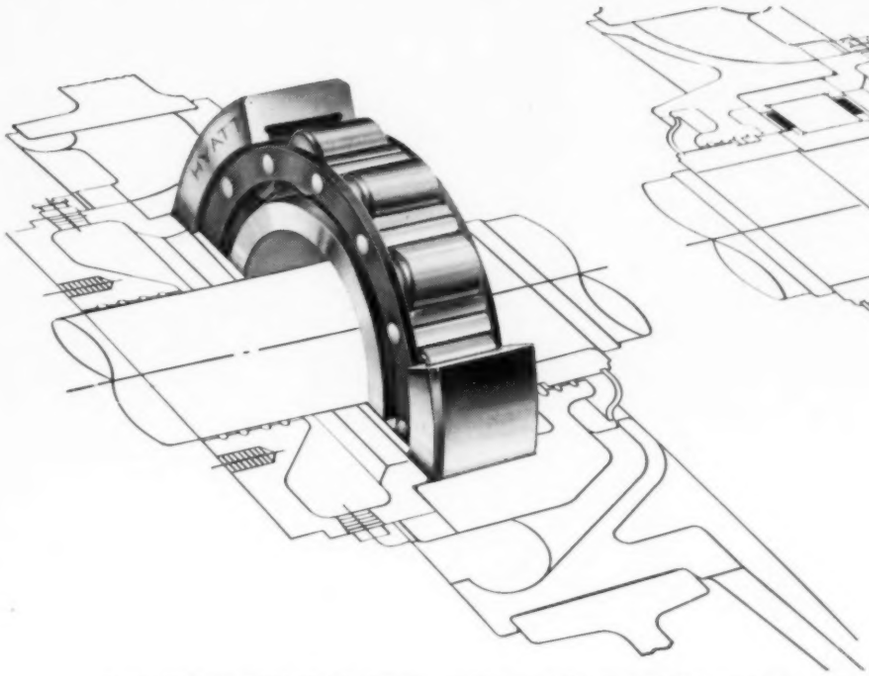

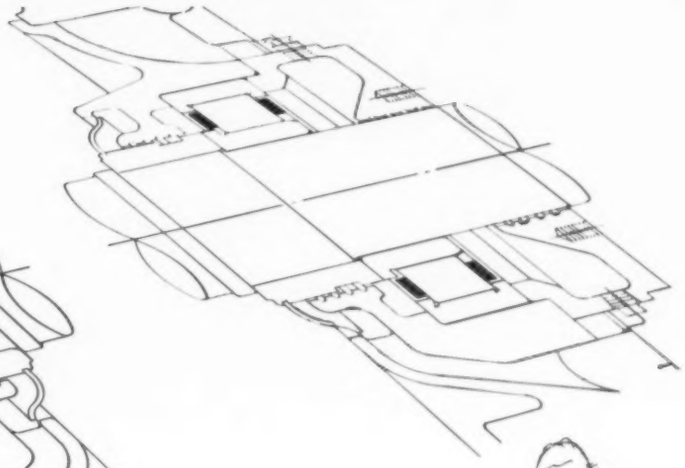

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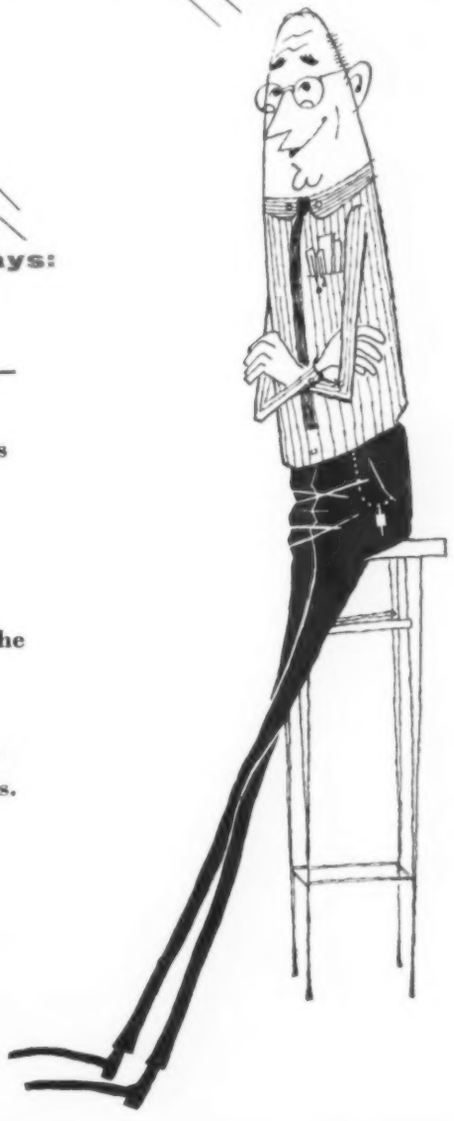
See why so many smart designers agree? *You can't go awry when you specify—*



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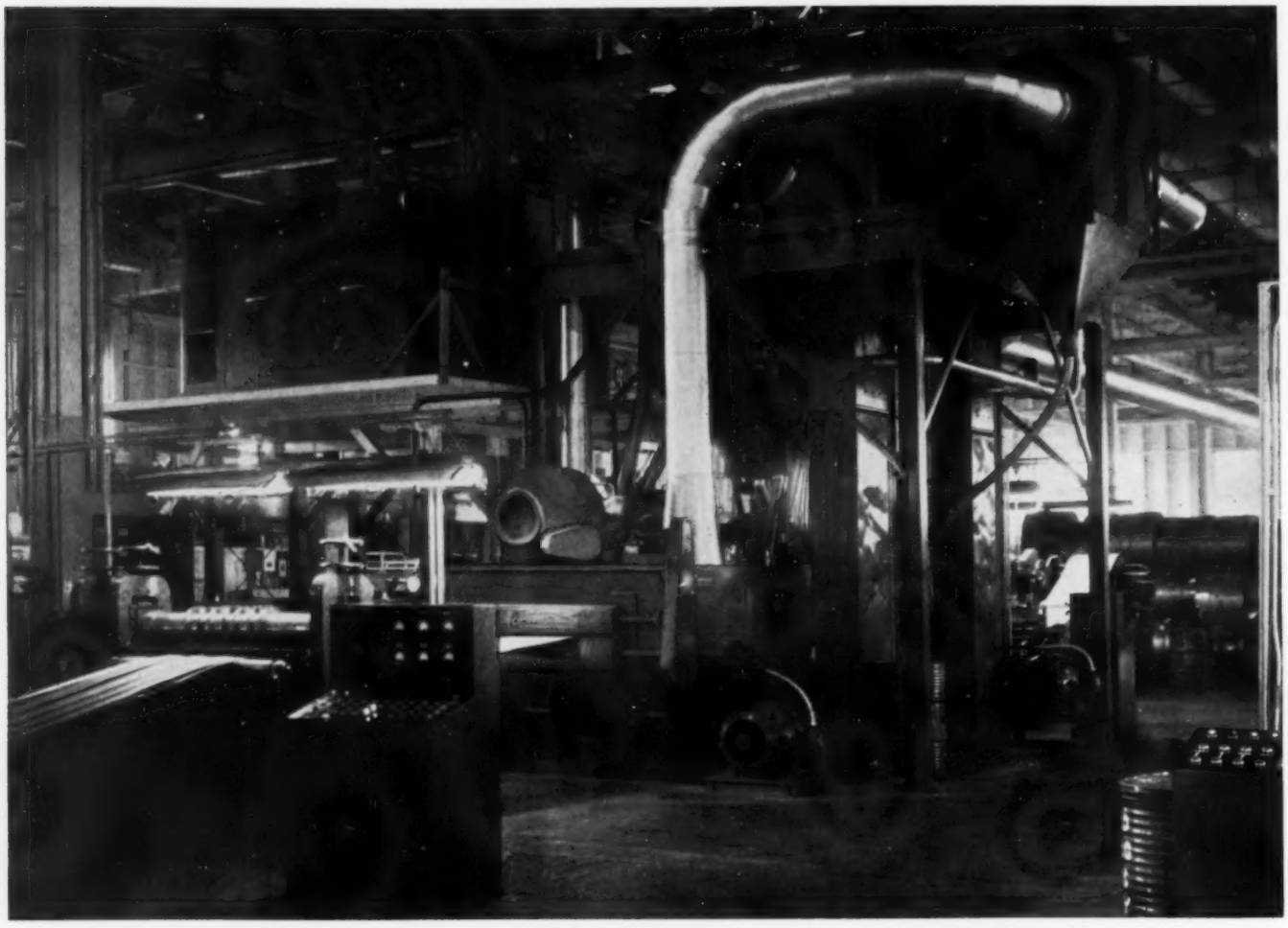
STRAIGHT ○ BARREL ○ TAPER ○

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

pioneering developments keep WHEELABRATOR® first in blast cleaning



8 Steps to Low Cost Cleaning of Steel Mill Products

Wheelabrator Mechanical Cleaning SAVES Time and Money—Eliminates Acid Handling and Disposal Problems

If you have any of these finishing problems, Wheelabrator Mechanical Cleaning can save time, money and space and improve your operations:

1. Ingot Mold Conditioning
2. Slab and Billet Conditioning
3. Continuous Strip Descaling
4. Sheet Descaling
5. Bar Stock Descaling
6. Wire Rod Descaling
7. Steel Shapes Descaling
8. Etching Mill Rolls

New developments in Airless Wheelabrator blast equipment and abrasives have eliminated all past objections to blast cleaning with an attendant reduction in costs. These have been proved lower than present pickling costs by the many Wheelabrator installations on all types of steel products.

With the Wheelabrator, scale is uniformly and economically removed leaving a surface ideal for cold rolling, cold forming, cold drawing and final finishing such as galvanizing or painting. By eliminating completely or partially the use of acid pickling, the Wheelabrator can equal or better your present costs without any virgin metal loss and with complete recovery of all scale as well as the abrasives used in its removal. Acid disposal problems are eliminated.

These impressive savings are being effected for steel producers and fabricators alike. Rome Cable Corp., for example, selected Wheelabrating for descaling steel strip because it was the only process that would remove surface scale economically and permit the rest of the plant to maintain its high production without requiring a major portion of its plant area.

Write today for complete information on this modern method of steel finishing for your problem.

Bulletin 894 describes the descaling of Steel Strip and Bulletin 914 describes the descaling of steel sheets. Send for your copies today.

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WHEELABRATOR & EQUIPMENT CORP.
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Wheelabrator®
AIRLESS BLAST CLEANING

Babcock & Wilcox Conducts Broad Research Programs

▲ THE research center of Babcock & Wilcox Co., started in 1947, now has eleven buildings. The original building, now used for products testing, has a high bay which contains pilot plants devoted to above and below critical testing, cyclone furnaces, combustion and heat transfer. A lower bay holds the chemistry and metallurgical laboratories, offices and machine shop.

Another building contains the engineering physics test section, and an annex is devoted to atomic research. Besides this annex, there is still another building where highly classified atomic research is conducted.

The administration building was put up in 1948, the welding building in 1951, and the alloy foundry in 1951. In addition, there is a shop building where instruments needed for research are assembled and repaired.

The creep laboratory at present in the basement of the administration building was started in 1926 at Massachusetts Institute of Technology with equipment owned by Babcock & Wilcox and the testing conducted by holders of B&W fellowships. It was moved to Alliance, and greatly expanded at the end of 1948.

Of the 354 people now at work at the research center, 121 are technical graduates including mechanical, chemical, electrical and metallurgical engineers, chemists, physicists and mineralogists.

Finding more efficient equipment to harness heat energy from all sources, whether it be locked in the nucleus of the atom or stored in the more familiar coal pile, is the goal of continuing research. Babcock & Wilcox is seeking to achieve major economies for its customers in such diverse industries as utilities, chemicals and petroleum. Outstanding examples of its accomplishments to date have been in the fields of super-critical boilers, fuel burning, alloy development and atomic energy.

The research center, with its chemical and metallurgical laboratories, special testing facilities, pilot plants, experimental furnaces and boilers, alloy foundry and machine shop, is fully equipped to investigate problems in fuels and their combustion, steam generation, heat transfer, and metallurgical and ceramic research to develop high-temperature alloys and refractories. It approaches this complex of problems via the avenues indicated by its three basic divisions: product development, materials development and technical service.

The research at Alliance is, of course, a continuing operation. While many of the results have already effected outstanding commercial improvements, many — equally valuable — have provided a firmer theoretical footing for further research and future improvements.

MAJOR DEVELOPMENT IN STEAM GENERATION AND FUEL BURNING

Investigations of boiler operations at super-critical pressures led to the development of the company's universal pressure unit, a major contribution to the drive toward realization of the large economies which exist in the realm of higher pressures and temperatures.

The company is now building a new high-pressure unit for the American Gas & Electric Co. First commercial unit of its kind, it will be located at the Philo, Ohio, plant of the Ohio Power Co. The unit will have a capacity of 675,000 lb of steam per hour. It will operate at 1150 F and at the super-critical pressure of 4500 psi.

Figure 1 — Aerial view of the Babcock and Wilcox Co.'s research center at Alliance, Ohio. The coal piles in the center, foreground, are special coals for testing purposes.

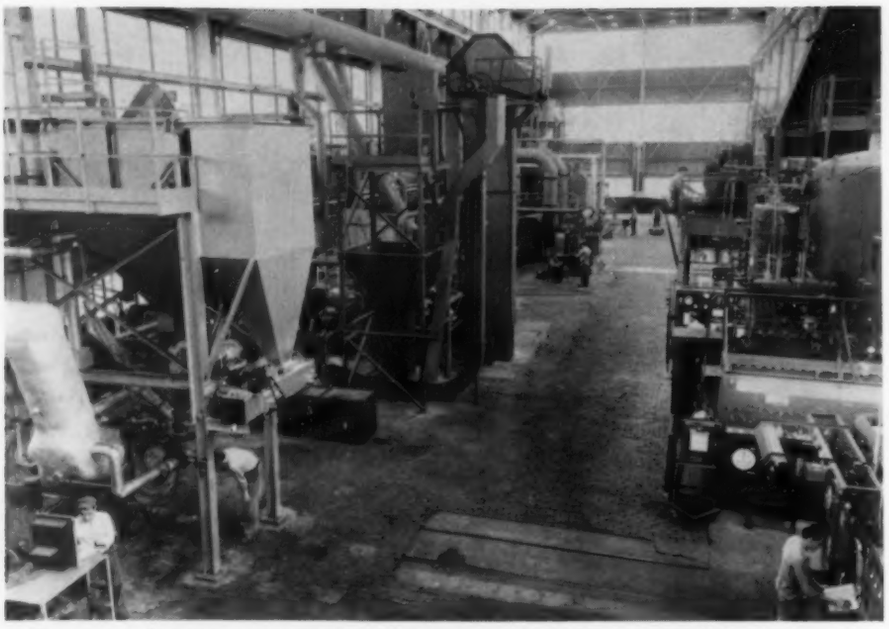


Figure 2 — Testing on several pilot plants at the Babcock and Wilcox research center is conducted to simulate service conditions. Through this means equipment and equipment components are developed to obtain optimum performance.

The part played by the research center in the development of efficient methods of firing pulverized coal and in the design of the cyclone furnace, which has revolutionized the burning of coal during the past 10 years, reflects a second important trend underlying much of the work at Alliance and in the field as a whole. Because more and more power plants are being forced to burn low-grade solid fuels, the need for increasing the efficiency of their utilization becomes ever more acute.

Studies made on coals from all over the world, and on such fuels as petroleum coke, have resulted in laboratory methods by means of which important commercial-scale burning characteristics of any solid fuel can be predicted. Research on the combustion of all types of fuel (coal, oil, gas, waste materials, nuclear energy) is a major part of the research activities. One of its outstanding results is a newly developed oil-burning cyclone furnace.

ADVANCED COAL-BURNING LOCOMOTIVE

Still another achievement of B&W research is the development of a high-pressure water tube boiler for use in a coal-burning locomotive. The boiler operates at 600 psi and 900 F, giving it high thermal efficiency. The first such Baldwin-Westinghouse locomotive, which combines the B&W high-pressure boiler with a Westinghouse steam turbine and electric drive, is rated at 4500 hp.

It operates at double the efficiency of the average coal-burning reciprocating steam locomotive, and can compete favorably with diesel-electric locomotives in industrial areas where cheap coal is abundant. After trials at Alliance, the boiler is being further tested by the Norfolk & Western Railroad. N&W is currently putting the new locomotive through actual road tests.

METALLURGICAL DEVELOPMENTS

In the field of metallurgical research, studies of super-strength alloys to withstand temperatures as high as 1250 F in steam boilers have produced five very promising compositions possessing long-time rupture strengths two to three times greater than that of the 18 Cr-8 Ni type alloys, which are now the strongest superheater materials available.

PIONEER IN ATOMIC FIELD

With its long experience in the utilization of fuels for steam generation, it was natural for Babcock & Wilcox to be among the pioneers in the development of atomic power. Because of its success in developing materials of construction, containing corrosive materials, fabricating and welding, and preventing radioactive leakage, the company has been chosen by Consolidated Edison to design, fabricate and erect the entire nuclear and steam-generating part of the first privately financed atomic power plant.

Furthermore, Babcock & Wilcox will be the first company to build a major private plant for the production of fuel elements and other reactor core parts for commercial nuclear power reactors. A B&W plant now under construction at Lynchburg, Va., will soon be producing fuel elements and reactor components.

A significant recent advancement in the field of atomic energy made by the research center is the development of a newly designed gasketed closure which prevents radioactive leakage from atomic reactors. An improvement over the solid weld—also developed by Babcock & Wilcox and used on the atomic submarine Nautilus—it eliminates the machine-tool cutting and rewelding previously required to open and close atomic reactors.

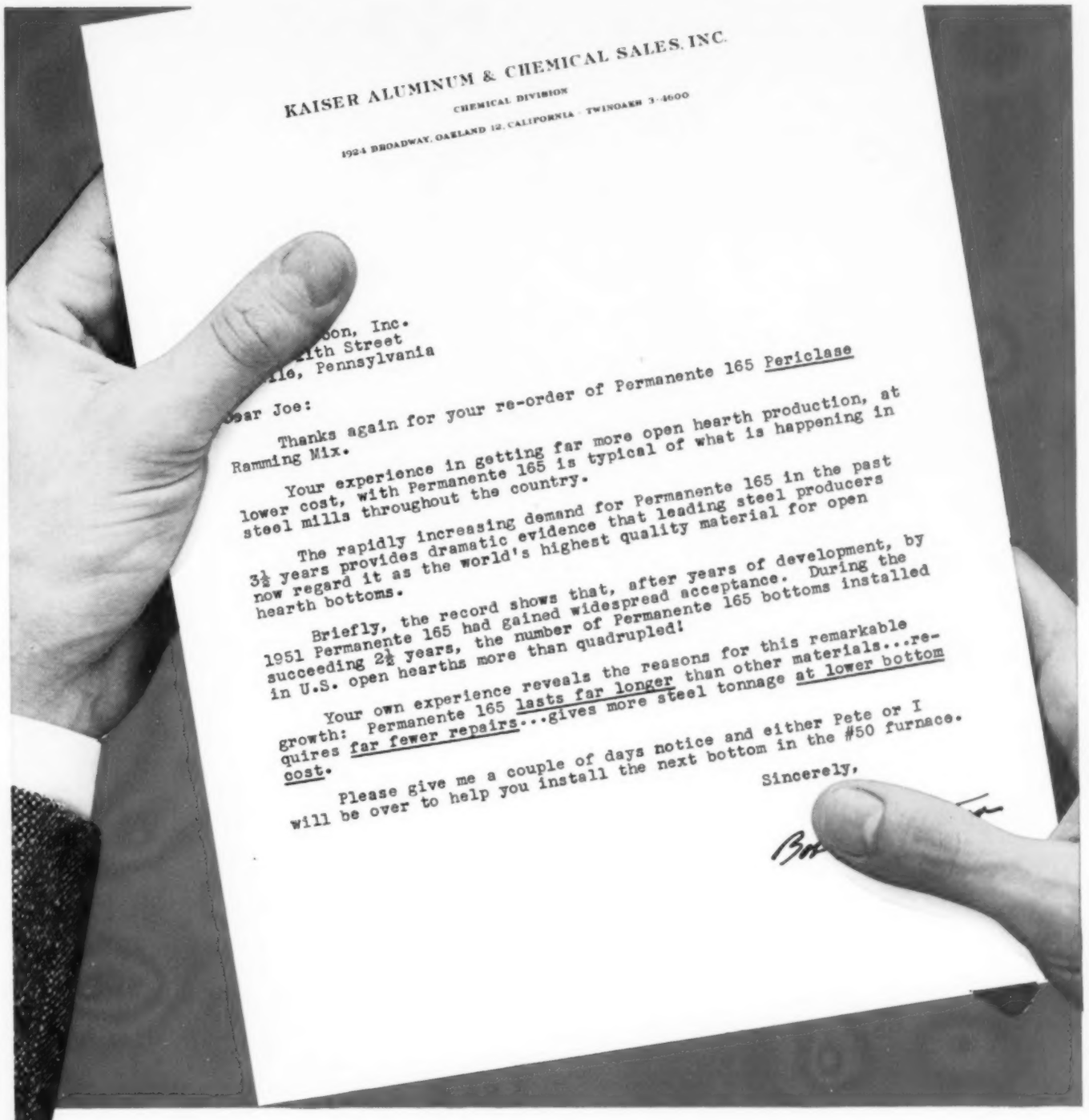
OTHER CURRENT DEVELOPMENTS

While much of the work has been specifically for the steam-generating industry, researchers are continually investigating and finding new applications for B&W products in many other industries. A case in point is the company's new refractory development, Kaowool. Interest in refractories led to the development of a new process for making Kaowool, which will now make this product competitive with long fiber refractories and superfine glass fibers for use in such diverse fields as household appliances and jet engines.

Currently Kaowool is being used as an insulating blanket in the afterburners and tailpipes of jet engines, where it successfully withstands temperatures up to 2000 F indefinitely.

B&W is now producing Kaowool at its research center in the form of a tough resilient blanket. No organic binder is used to hold this blanket together. Hence, the blanket retains its full strength and coherence at much higher temperatures than other high-temperature refractory blankets. In this form, Kaowool can be successfully hung inside an inclosure without settling and without needing to be sandwiched between retaining walls.

Kaowool is a pure white homogeneous fiber made by melting and blowing kaolin, the clay from which it takes its name. The material does not melt below 3200 F, and as a fiber, can withstand temperatures up to 2000 F without change or loss of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The rapidly increasing demand for Permanente 165 in the past 3½ years provides dramatic evidence that leading steel producers now regard it as the world's highest quality material for open hearth bottoms.
Briefly, the record shows that, after years of development, by 1951 Permanente 165 had gained widespread acceptance. During the succeeding 2½ years, the number of Permanente 165 bottoms installed in U.S. open hearths more than quadrupled!
Your own experience reveals the reasons for this remarkable growth: Permanente 165 lasts far longer than other materials...requires far fewer repairs...gives more steel tonnage at lower bottom cost.
Please give me a couple of days notice and either Pete or I will be over to help you install the next bottom in the #50 furnace.
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resiliency. It thus surpasses standard glass wools, which begin to deteriorate at 1000 F, and rock wool, which is only effective up to about 1200 F.

To make the fiber, kaolin clay is first electrically melted. The molten material then streams through a tapping nozzle and is blown into fibers. The processed Kaowool is then collected on a pad-forming conveyor.

Kaowool was first produced only in bulk form. A technique for blowing fibers into lengths of eight in. or longer, which uses high-pressure air, made the manufacture of the blanket possible.

Besides lengthening the fiber, the new process has reduced individual fiber diameters to about 3 microns, or about one-thirtieth the diameter of a human hair. Small fibers are particularly desirable for improving the insulating value at all temperatures and to give the material a soft, cottony texture.

Kaowool is now being turned out by a pilot plant at the rate of a half ton a day. A full-size plant is a distinct possibility, B&W says. As a result of recent experiments, the company feels the present process can easily be adapted to large-scale production.

At the research center, B&W is also studying the thermal conductivity of Kaowool for both high- and low-temperature applications. Inasmuch as orientation and uniform density of the wool greatly affect high-temperature conductivity, the blowing duct and pad-forming conveyor are currently being improved to provide this better orientation and distribution of the fibers.

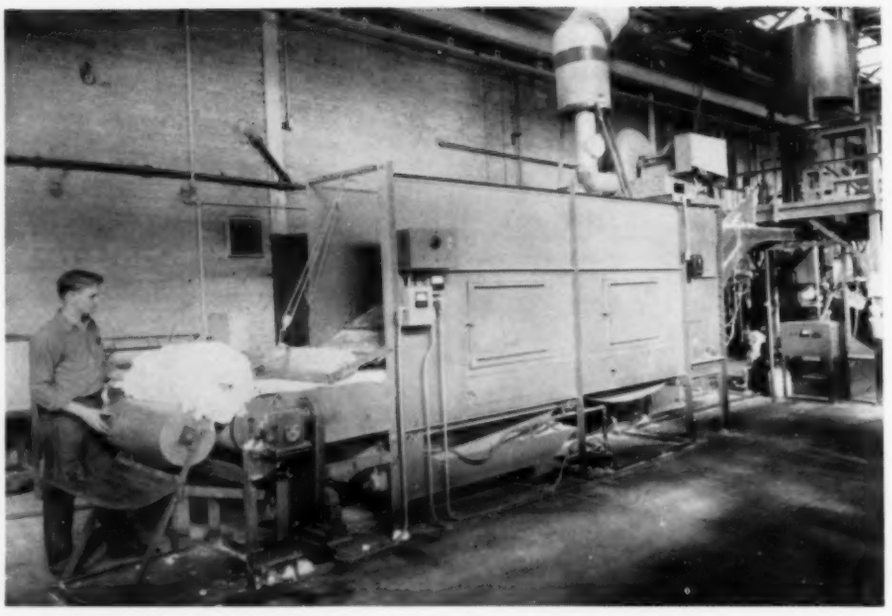


Figure 3 — Pilot plant for the production of B & W Kaowool insulating refractory blankets. Design of the pilot plant resulted from a new method of manufacturing Kaowool recently developed at the center.

Other examples are the development of high-temperature, high-pressure tubing for manufacture of polyethylene, bubble tray steam washers which also may be used as humidifiers for gas turbines, and special furnace-type reactors for gasifying coal for the production of synthesis gas.

Additional accomplishments to come out of continued investigations at the research center includes welding equipment for a new automatic submerged-arc process that deposits metal five times faster than present automatic processes; steam purification equipment that is expected to solve the troublesome maintenance problem of preventing silica deposits in turbines.

OTHER B&W RESEARCH FACILITIES

Although most of the company's investigations are carried on at Alliance, it maintains research facilities at each of its manufacturing locations. For example: the plant of the Tubular Products Division at Beaver Falls, Pa., has a new laboratory with equipment for inspection and testing procedures as well as for the development of new alloys; the company's laboratory in Augusta, Ga., conducts development work on insulating and refractory materials; and the plant of the Boiler Division at Barberton, Ohio, has a laboratory for investigating many subjects having to do with the theory and application of fabricating processes.

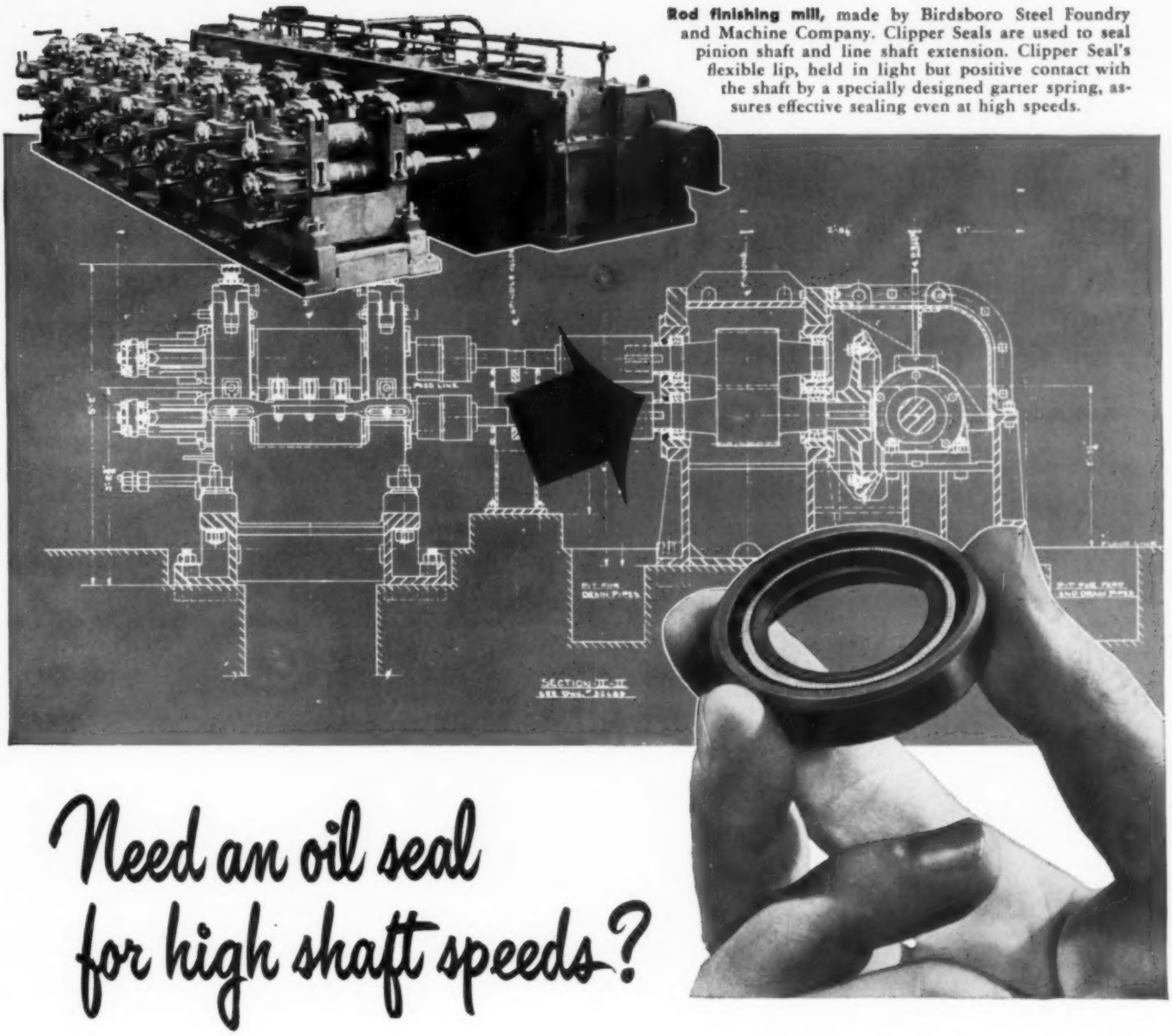
New Drawing Equipment Shown to Industry

▲ AT a recent demonstration at their Ellwood City plant, the Aetna-Standard Engineering Co. displayed one of the largest draw benches ever made and a new inverted bull block. Both of these units were built for the non-ferrous industry.

DOUBLE CHAIN DRAW BENCH

The draw bench is believed to be the largest ever built as far as physical size is concerned. Its maximum pull of 150,000 lb at 100 fpm is, however, one-half the largest capacity units now built by this company. The bench is designed to be used at four draw speeds of 110, 165, 220 and 330 fpm at corresponding pulls of 150,000, 100,000, 75,000 and 50,000 lb respectively. Speed variation is accomplished by a two-speed main-drive powered by a 500-hp, 900/450-rpm, a-c motor. An air-flex clutch is used to obtain lower hooking speed. The carriage return speed is 500 to 1000 fpm, and the pinch roll speed is 880 fpm.

One of the features of the bench is the air operated, five-draw carriage head. The use of air speeds up production and permits gripping close to



Rod finishing mill, made by Birdsboro Steel Foundry and Machine Company. Clipper Seals are used to seal pinion shaft and line shaft extension. Clipper Seal's flexible lip, held in light but positive contact with the shaft by a specially designed garter spring, assures effective sealing even at high speeds.

Need an oil seal for high shaft speeds?

Birdsboro chose Clipper Seals

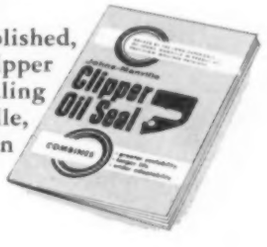
The Birdsboro 8-stand finishing train shown above is expected to operate around the clock, day in and day out. And since it is to be part of a large, high-speed, steel rod producing unit, Birdsboro designed it to be as maintenance-free as possible.

In order to minimize down time, particular attention was paid to bearing design and lubrication. The mill stands are equipped with open, water-lubricated bearings. Because of high shaft speeds, bearings in the combination spiral bevel gear reduction and pinion stand are anti-friction in type, lubricated with circulating oil, and sealed with Clipper Seals.

Birdsboro engineers chose Clipper Seals for this application because of their outstanding ability to withstand the heat of friction generated by high shaft speeds . . . and their ability to make a tight and lasting seal against the circulating bearing lubricant.

Still other reasons for Birdsboro's preference for Clipper Seals: They are precision-molded, compact in design, and exceptionally easy to install. They may be removed and replaced without impairing their sealing efficiency. And because of their unique design, Clipper Seals cause a minimum of shaft wear.

Free Brochure PK-71A, just published, shows how the wide variety of Clipper Seal designs meet almost every sealing condition. Write to Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ontario.

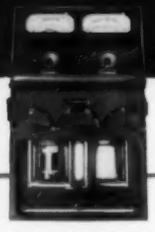


JM PRODUCTS

Johns-Manville CLIPPER SEALS

THIS IS INLAND STEEL!

The Cities Service Heat Prover Works Here



THE PORTABLE HEAT PROVER is supplied and maintained free by Cities Service. It helps control combustion efficiency by allowing rapid, continuous sampling, simultaneous readings and direct measurement of oxygen and combustibles. Inland uses the Heat Prover for its blast furnaces, open hearths, soaking pits, continuous galvanizing line, reheat furnaces, purging operations, annealers, and boilers on ore ships.

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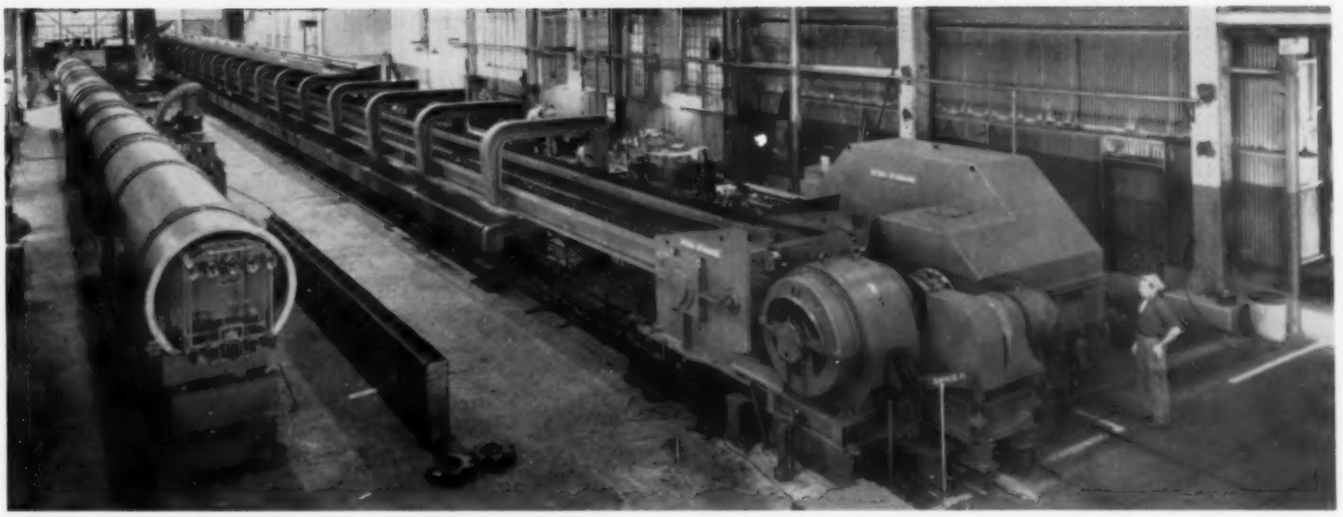


Figure 1 — View shows mandrel and draw bench setup side by side in the assembly shop. In actual practice the mandrel unit on the left will be located at the far end of the draw bench which is shown on the right.

the die stand, and the carriage action does not require actual contact with the die stand. This is a new feature which has been incorporated during the past year. The maximum length of tube before drawing is 150 ft and 200 ft after drawing. With a single draw, tubes up to 5-in. outside diam can be handled, and this is reduced to 3-in. outside diam when the bench is used for triple or five-draw operation.

Die sizes are 14-in. outside diam for single draw and 6-in. outside diam for triple and five-draw operation. For single-draw operation, the maximum point size is 5-in. outside diam and for triple or five-draw operation, the maximum point size is 1¾-in. outside diam.

The loading rack has a capacity of 100 3-in. outside diam tubes. When installed for operation, the overall length is about 350 to 400 ft.

One man is capable of operating the unit. The equipment was made for a production operation in which the material produced will usually be further drawn into smaller sizes where the long lengths can be handled in coil form. However, where a steel producer has a market for appreciable runs of the same size cold drawn product in long lengths, the equipment merits consideration.

BULL BLOCK

The bull block shown was designed to fine draw material from the 150,000-lb bench into smaller size coils. Actual production in the plant buying this unit will be primarily for refrigerator coils. This bull block has a capacity of 10,000 lb at speeds from 150 to 500 fpm reducing to 3300 lb at 2000 fpm. Speed selection for this range is by means of a manually operated rheostat. This unit is driven by a 150/200-hp, 300/1200-rpm, 230-volt motor which is operated from an adjustable voltage package drive. The drum is 60 in. in diameter with a 52-in. face. Maximum starting size for the copper tube is 1½ in. outside diam. An example of a typical copper tube drawing cycle would be to start with a tube 1.234-in. outside diam with an 0.055-in. wall and finishing this in eight passes to 0.249-in. outside diam with an 0.029-in. wall.

A special coil pay-off, integral with the bull block, has retractable and centering rolls which aid in the handling of the coils. The gripper is air operated.

The die box is of the traversing type and has built into it a three roll straightener which removes the coil set. A variable speed hydraulic traverse helps in the coiling.

Figure 2 (left) — Air operation of the carriage is an important feature in the productivity of the unit.

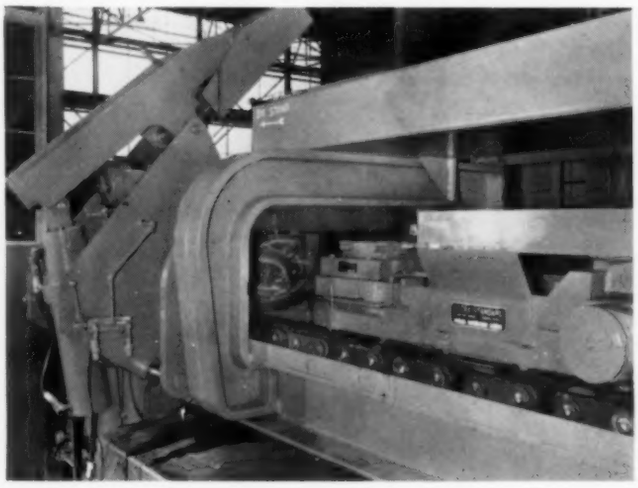
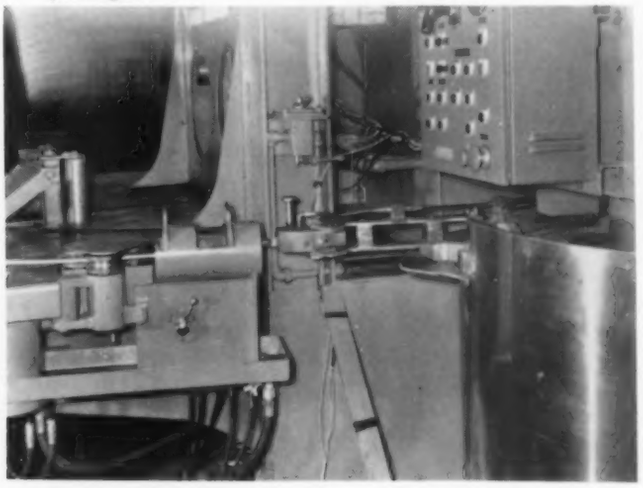


Figure 3 (right) — Closeup view of bull block shows in detail gripping unit. The coil after being drawn is wound around drum shown at the right. Coil being drawn is mounted at left and drum on left is lowered during drawing operation at a rate which will give level winding. Convenient operator's control panel is seen at upper right.



RESISTANCE WELDING MACHINE FABRICATES WIRE MESH

▲ A huge new mechanically-operated high speed resistance welding machine that produces wire mesh up to 13-ft wide from coiled steel wire in a continuous operation has been developed and built by Expert Welding Machine Division, 17144 Mt. Elliott Ave., Detroit 12, Mich. The compactly designed machine and its accessories are about 7-ft high and occupy a floor space about 35 by 32 ft. It will fabricate mesh from 4 to 14-gage wire at a rate of 60 cross wires per minute. Extreme operating flexibility is provided in the machine, which will handle up to 79 longitudinal wires with a wire spacing from 2-in. up. Cross wires can be spaced from 2 to 12-in. The machine will produce wire mesh in either square or rectangular patterns as desired.

High speed operation of the machine is accomplished by feeding six cross wires at a time, cutting them off and conveying them to a hopper from which they are fed one-at-a-time to a resistance welding crosshead upon which up to 79 individual spring-loaded welding guns are mounted.

This multiple cross wire feed unit, is for use on heavy gage cross wires up to 3/8-in. diam. Where light gage wire is used a single wire cross wire feed is provided.

The welder consists of five basic units: a longitudinal wire straightener, a multiple cross wire feed, straightener and cutoff machine, a resistance welding crosshead, a slitter and a coiler.

Longitudinal wires in coil form are fed through the straightener unit to the welder crosshead. A single straightened and cutoff cross wire is dropped over the longitudinal wires and pulled in welding position by a set of fingers. Then the cross wire is welded by the toggle-controlled welding crosshead. The fingers pull the welded cross wire to index the longitudinal wires to the next welding position. A second set of fingers simultaneously grasp another set of welded cross wires on the mesh and thus permit the longitudinal wires to be pulled through the straightener unit without deforming any of the welded cross wires.

From the welding unit, the mesh is fed to a slitter where it is cut to the desired widths. The slitted mesh is directed to a coiler where it is wound in coils.

The multiple cross wire feed, straighten and cutoff machine takes wire from six individual coils. The wires are fed through six individual rotating arbor-type straighteners. When the wires have reached the proper length, all six wires are simultaneously cut off and dropped on a screw-type conveyor. This conveyor feeds the wires into a hopper from which they are delivered one-by-one and pulled into the weld station.

The wire mesh welder is easily set up and adjusted to suit both volume and small quantity production requirements of a wide variety of mesh spacings and widths.

DESIGN FEATURES

The machine is entirely mechanically operated. One main shaft, driven by a 15-hp motor and speed reducer combination, controls all of the functions of longitudinal wire indexing, cross wire hopper operation, and welder crosshead operation through eccentrics and toggle linkages. Compact design of the welder crosshead is achieved by grounding all of the gun units to a shunting bar. The lower electrodes in the welder unit are connected to secondary transformer leads so that two series welds are made through two adjacent guns. The guns are individually adjusted transversely.

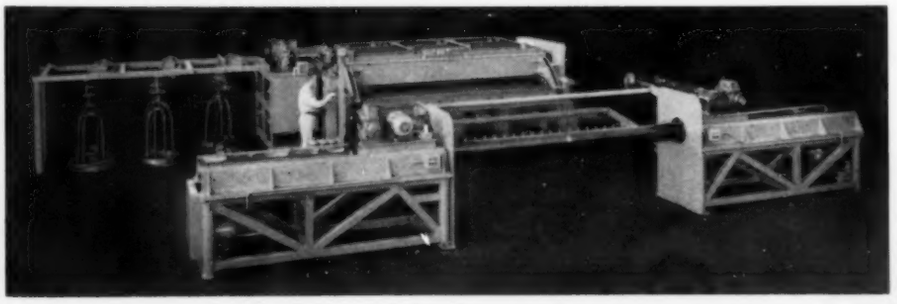
The main shaft operates the welding crosshead through specially designed inverted toggle mechanism. This design provides a long dwell arrangement which contributes to the high operating speed of the machine; making half the crosshead operating cycle time available for welding. The cross wire feed, straighten and cutoff unit has several motor drives. Three 5-hp motors power the arbor-type straighteners; each motor driving two arbors. Two sets of drive rolls are provided for each wire; one set ahead of each arbor and one behind it. A 15-hp motor powers all drive rolls.

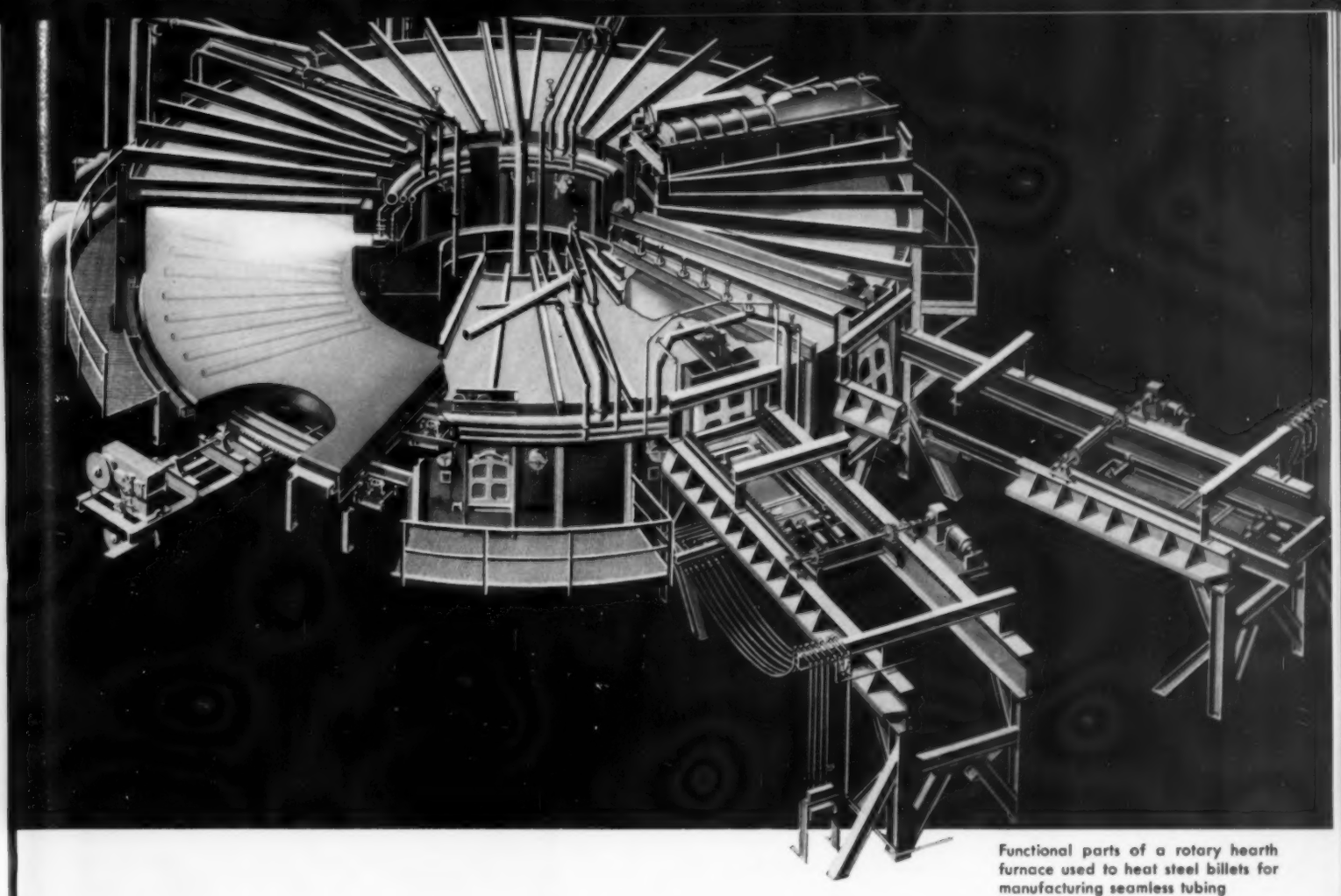
The drive roll motor is a two-speed type, the higher speed of this motor produces wire at a rate exceeding the requirements of the welding machine. The lower speed of the motor will produce wire at a rate less than the welding machine requirements. The motor cycles between high and low speed, depending on the fill condition of the hopper.

The cross wire cutoff mechanism is an eccentric and crank type driven by a 3-hp motor through an electric clutch and brake unit. A 1-hp motor powers the five screw conveyors that advance the cut-off wires to the hopper.

The coiler has two 10-in. diam mandrels that pilot into each other. The mandrels are each powered by a 5-hp motor and speed reducer units. To remove wound coils, each mandrel is retracted axially by a 5-hp motor and lead screw mechanisms. A take-up roll controls mandrel motor operation to keep coiling of mesh in synchronism with the production rate of the welder.

Figure 1 — The new wire mesh welder makes wire mesh up to 13 ft wide from coiled wire stock in a continuous, high-speed operation.





Functional parts of a rotary hearth furnace used to heat steel billets for manufacturing seamless tubing

Increase Productivity, Save Space, And Cut Fuel Costs With Salem-Brosius Rotary Hearth Furnaces

Most large rotary hearth furnaces in the world have been designed and built by Salem-Brosius or its licensees. Salem-Brosius developed the large rotary hearth furnace and continuously has improved its design and construction.

Salem-Brosius rotary hearth furnaces are in use today for production heating and heat treating carbon and alloy steel bars, slabs, round and square billets, shell stock and forging stock; and similar products in non-ferrous metals such as copper and brass.

The rotary type furnace saves floor space. Fuel efficiencies and economies are unequalled by any other type of industrial furnace. Heating is rapid and uniform. Charging and discharging is mechanical; and automaticity of control drastically cuts labor costs. A Salem-Brosius rotary hearth assures the minimum of maintenance and repair costs. These benefits spell higher furnace output, less downtime, lower production cost—and greater profit to you, the user.

The rotary hearth is but one of the many types of Salem-Brosius furnaces—furnaces of superior design and construction—furnaces that help improve your product and turn it out at a lower cost. If your plant modernization plans call for heating or heat treating furnaces of any kind, call on Salem-Brosius.

Other Salem-Brosius products include forging manipulators, furnace charging and discharging equipment, hot materials handling equipment, large gas main valves, blast furnace clay guns, and a long list of special machinery and auxiliary furnace equipment. A Salem-Brosius engineer will be glad to help you with problems involving any of this equipment, or any special equipment that must be tailored to your needs. Write to us.

SALEM-BROSIUS, INC.

CARNEGIE, PENNSYLVANIA

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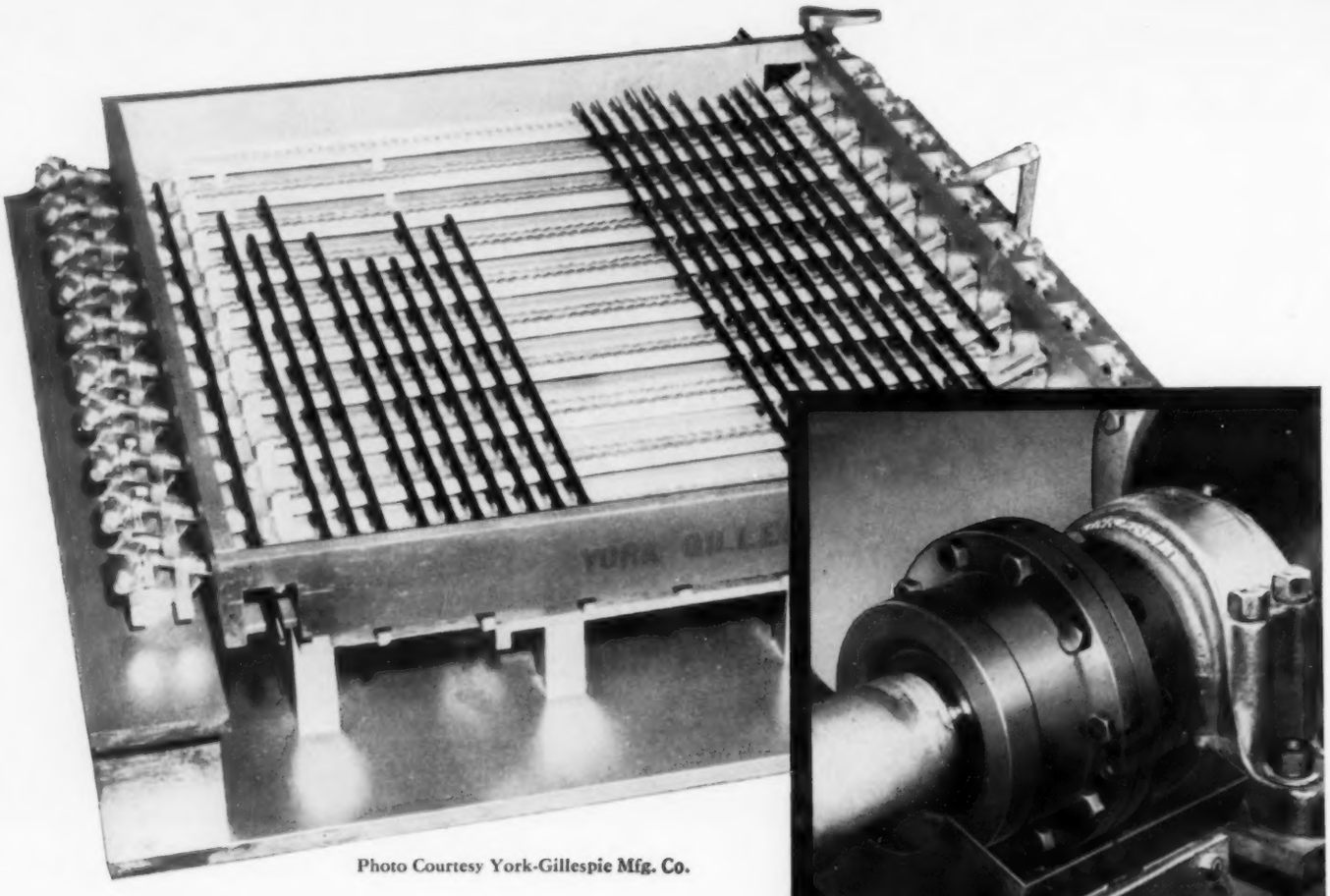

Photo Courtesy York-Gillespie Mfg. Co.

Photo Courtesy Jones & Laughlin Steel Corp.

Fast's Couplings help roll 30 tons of steel per hour through new Jones & Laughlin normalizing and quench tempering furnaces

At the Jones & Laughlin Aliquippa Works, Fast's Couplings are part of a new materials-handling process for transferring tubular steel products through the continuous normalizing and quench tempering furnaces. Pipe tubing is rotated automatically by a series of specially designed racks as it is transferred through the furnace. This design eliminates chill spots and minimizes warpage, insuring uniform heating at capacities up to 60,000 pounds per hour.

Fast's Couplings were used exclusively in this equipment . . . and for good reasons: They are subject to operation at extremely high temperatures that demand Fast's all-steel construction; torque transmission is high (low 3 RPM speed at eccentrics); Fast's Couplings offer mis-alignment protection for long-distance shafting—particularly important because of high temperatures and subsequent shaft growth; and Fast's Couplings are the best "shut down insurance" where continuous, trouble-free operation is essential.

This is another example of how Fast's Couplings fill specialized needs of industry with their famous Fast's construction and performance features. Koppers free engineering can assist you in selecting the right Fast's Coupling for your needs also. Mail the coupon below for a free catalog to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 216 Scott St., Baltimore 3, Maryland.

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Quick-Connect Coupling Used in Pipe Testing Program

▲ BY ingenious use of a special type of quick-connect hose coupling, the Pittsburgh Steel Co. was able to develop a simple, low-cost supplement to its regular facilities for high pressure testing of steel pipe on a production basis.

The sudden peak load for high pressure pipe testing developed because the American Petroleum Institute recently adapted a specification requiring that steel tubing used in oil well drilling operations be tested to 80 per cent of minimum yield strength. This amounted, in a number of sizes, to test pressures as high as 10,000 psi.

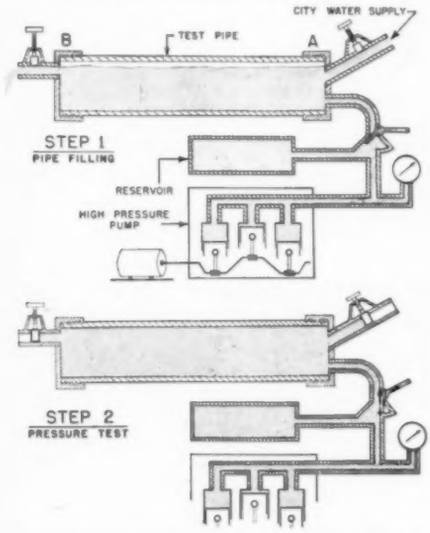


Figure 1 — In step 1, pipe under test is filled rapidly from city water supply. Pipe fills till bubble-free flow comes out of end B, showing pipe is free of air. Then in step 2, outflow line is closed, city water supply is shut off, and high (10,000 psi) test pressure supply is connected to pipe.

The effect of this new specification was to suddenly increase greatly the high pressure pipe testing load at Pittsburgh Steel's seamless tube mill at Allenport, Pa., where a large output of this product is manufactured. One obvious way to meet this increase in production testing load would be to add another standard commercial machine especially designed for high-speed testing of steel pipe at high pressure, such as Pittsburgh Steel already has. These machines, however, take months to build and their cost requires a capital outlay that could only be warranted by continuous, full scale operation. So it was decided to look into current developments in quick-connect hose couplings for use in a simpler, less costly machine which could be made at the plant, and built quickly enough to be useful in meeting the temporary testing overload.

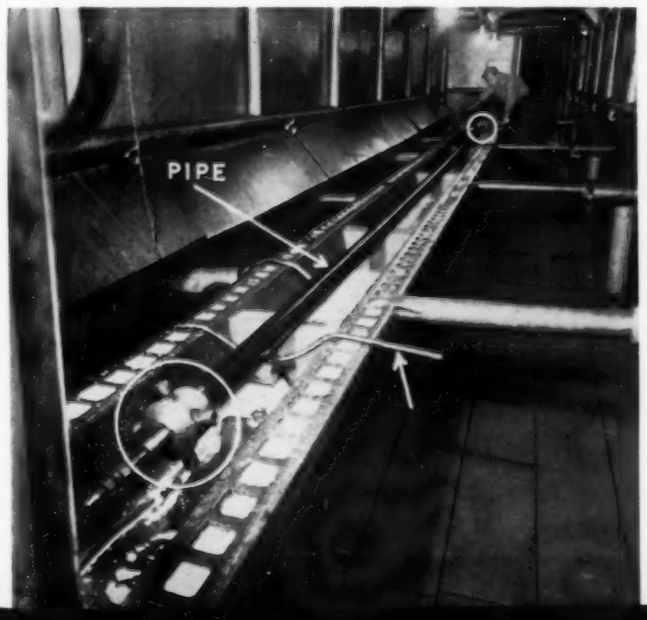
To put this idea into effect, the set-up sketched schematically in Figure 1 was first tried. In this arrangement solid end caps are threaded onto both ends of the pipe to be tested. Water from city lines first flows in at end A till it comes out through the small pipe in end B in a steady, bubble-free stream, indicating that all air has been removed from the pipe. This little overflow pipe is then plugged and the pipe under test is connected to a very small water supply from a high pressure pump. The pump pressure builds up in the pipe under test, and the pressure is indicated on a gage.

Full pressure (9700 psi) is kept on for 0.1 min. In the actual set-up (Figure 2) a protective hood over the entire test equipment shields shop and personnel from injury in event of test pipe failure; and a rack (Figure 3) permits convenient movement of the pipe length under test into and out of test position.

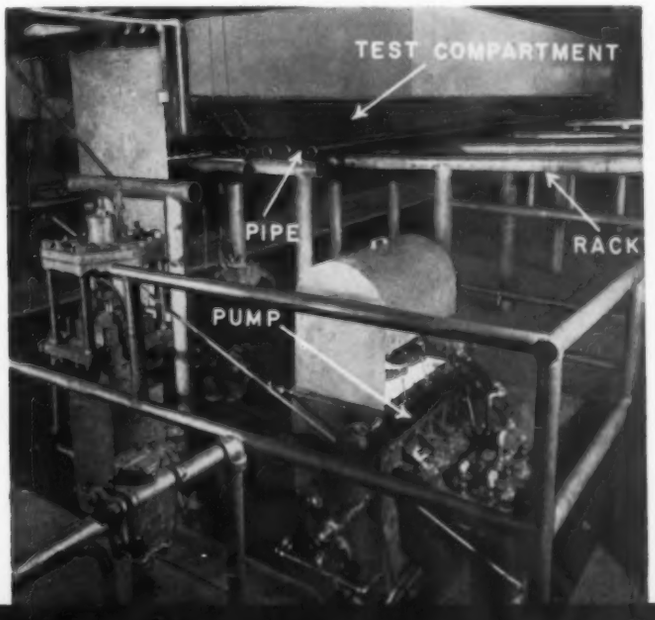
This arrangement is simple enough, but to be practical for rapid production testing these two important design details had to be successfully mastered:

1. It should be possible to rapidly connect and shut off city water supply to fill the pipe under test.

Figure 2 (left) — Overall view of low-cost set-up for high pressure production testing of oil well pipe developed by Pittsburgh Steel Co. Pipe to be tested rolls in from right, is rolled out at left after test. Test pipe is easily rolled out after test by lifting end of bent supporting bar (arrow). Note steel hood protective enclosure.



Filling and pressure supply connections to test pipe are made through end caps (circles). Figure 3 (right) — This view shows high pressure supply pump in pit, and inclined loading rack which allows pipe to be tested to roll by gravity into test compartment.



2. It must be possible to switch rapidly from city water supply for filling the test pipe to a small high pressure supply for testing.

The Titeflex Quick-Seal coupling was found to meet all requirements for high pressure operation; it was strong enough to withstand the high test pressure, its seal did not leak at high pressure, and the coupling ends were securely locked together. These

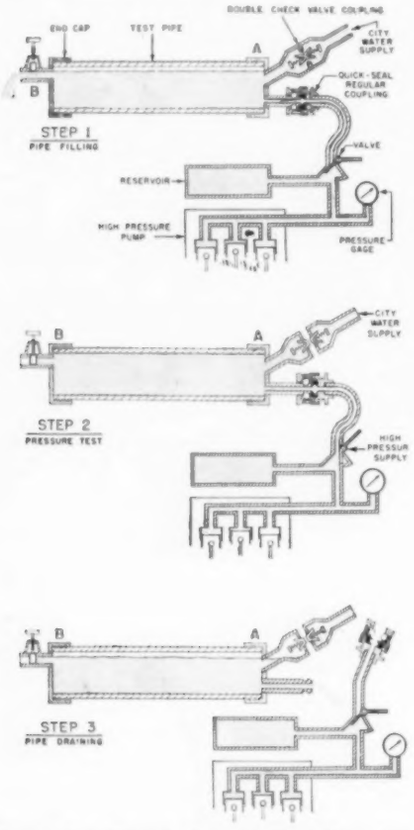


Figure 4 — Step 1 shows filling the pipe under test. Double check valve coupling in city water supply line is connected. Both check valves are thus kept open, city water supply fills pipe under test. Valve at end B permits outflow of city water until bubble-free flow shows test pipe free of air. In step 2, double check valve coupling is opened, city water line and test pipe automatically shut. High pressure supply is connected to test pipe through quick-connect coupling. In step 3, pressure test is completed, high pressure supply shut off; and water in test pipe is quickly drained by opening quick-connect coupling at A.

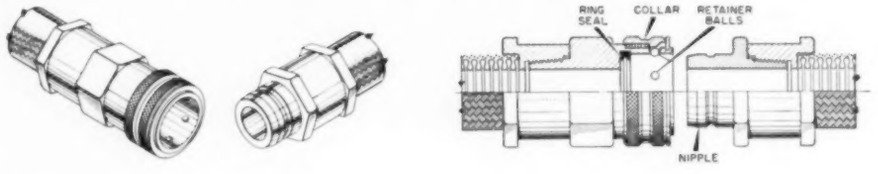
characteristics are all due to a few simple but vital design features built into the straight-through and check-valve types of Titeflex Quick-Seal couplings. These features become readily apparent if one follows through the step-by-step operation of the coupling illustrated in Figure 5. As shown in this figure, to connect the Titeflex Quick-Seal coupling the nipple is inserted into the body (Sketch B); the collar is retracted (Sketch C); this lets the nipple seat solidly on the ring seal; the collar is then released (Sketch D), which pushes the retainer balls into the groove and locks the coupling ends together.

In this construction, the features which provide the desired high pressure characteristics of the coupling are as follows: In the first place, the nipple groove (Figure 5) has steep walls whereas in other couplings the groove sides are shallow. When high pressure tries to force the coupling's nipple and body apart, the balls merely dig into the steep groove wall —they cannot be forced to ride up and over it.

The characteristic of being leak-proof at high pressure is due to the V-type ring seal. As will be seen from Figure 5, increase of pressure expands the lips of the seal ring, and only makes the seal between coupling body and nipple tighter the higher the pressure.

The high burst strength of the coupling comes from the fact that it has straight-through flow. In other types of quick-connect couplings, which do not have straight-through flow, it is necessary to increase the diameter of the coupling considerably to keep flow obstruction down to a low value. In order to prevent the outside diameter of the coupling from becoming excessive when this is done, it is the practice in such coupling designs to make the outer wall thickness as small as possible. In the Quick-Seal coupling, on the other hand, the straight-through flow provides so little obstruction that coupling can be made of thick wall section even while keeping body diameter very little larger than the diameter of the hose.

Figure 5 — Sketch A. Operation of Titeflex Quick-Seal hose coupling; coupling disconnected. Outside view, left; action inside, right.
Sketch B. Operation of Titeflex Quick-Seal hose coupling. First step in connecting coupling; nipple inserted in coupling body. Outside view left; action inside, right.
Sketch C. Operation of Titeflex Quick-Seal hose coupling. Second step in connecting coupling; collar on coupling body is retracted, nipple pushes retainer balls outward as it moves in. Nipple end seats against seal ring, forms leak-proof seal. Outside view, left. Action inside, right.
Sketch D. Operation of Titeflex Quick-Seal hose coupling. Final step in connecting coupling; collar on coupling body is released, is snapped back by spring, forcing retainer balls into groove. Coupling and body are thus locked together. Pressure of fluid inside coupling expands lips of seal ring, makes coupling leakproof at high pressure. Retainer balls in groove keep coupling sections locked together, but permit hose to swivel freely.

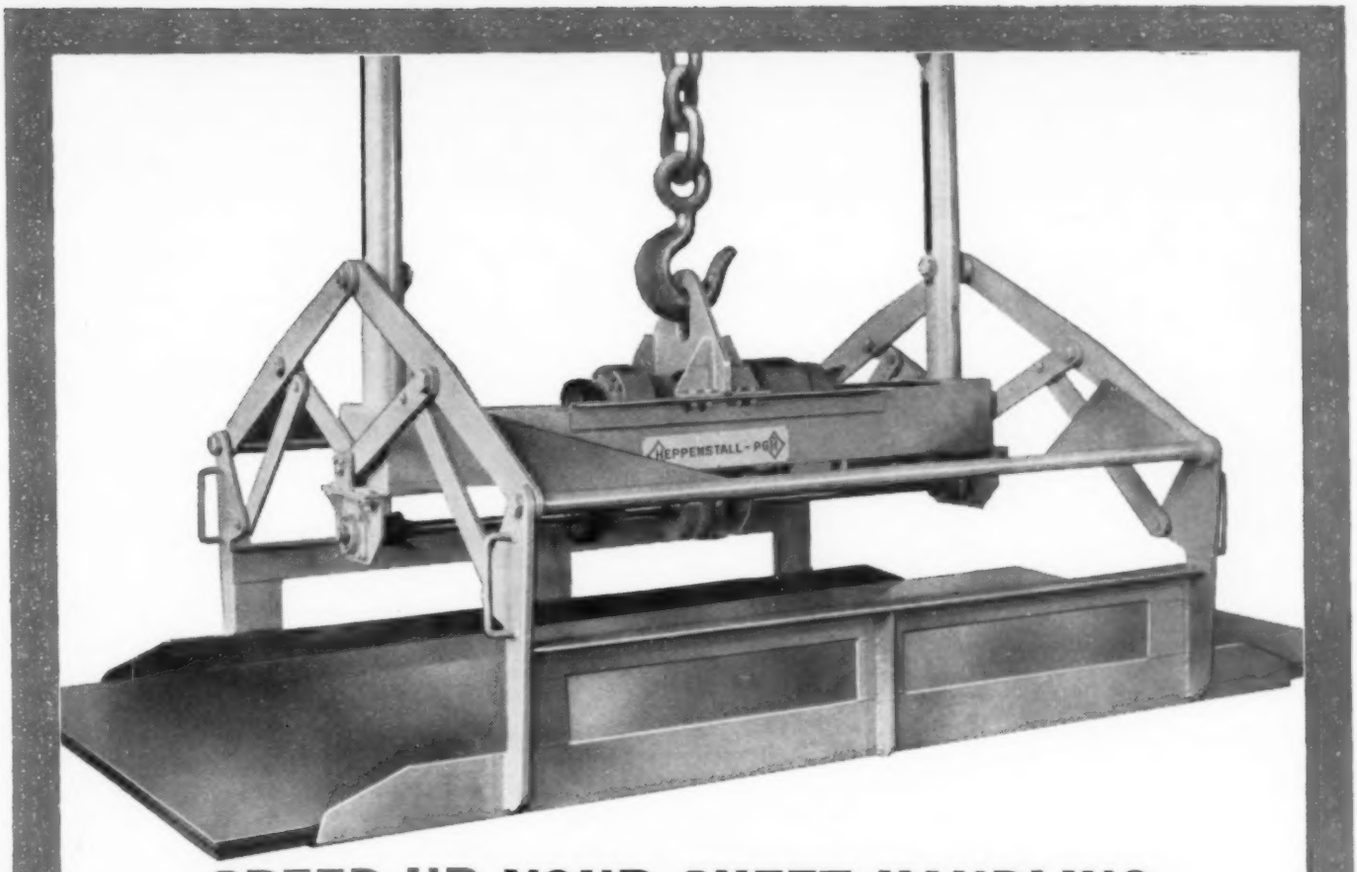


Sketch A

Sketch B

Sketch C

Sketch D



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This latest addition to the Heppenstall line of tongs has remarkable safety and ease-of-operation features that will save you both time and expense. Its design and construction solve many problems in sheet handling, and offer you these important advantages:

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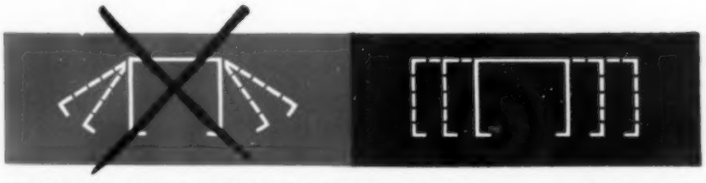
2. **Decreases sheet damage because of straight line motion of lifting arms.**
3. **Cannot lose load because of self-locking brake.**
4. **Available in hand or motor operated models.**
5. **Unlimited capacities.**
6. **End Grabs for use with very wide or very long sheets can be added as optional equipment.**
7. **Designed to fit any crane block and hook equipment.**



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GREAT LAKES STEEL BLOWS IN NEW BLAST FURNACE

▲ A new blast furnace — the world's largest — was blown in on June 5th at Great Lakes Steel Corp., Detroit, Mich., a division of National Steel Corp. Designed and erected for Great Lakes Steel by the Freyn Department of Koppers Co., Inc., blast furnace "A" has a hearth diameter of 30 ft, 3 in.

William Collison, superintendent of blast furnaces and coke plant, indicated that the blow-in operations progressed normally.

Commenting on the record-breaking hearth dimension, Owen R. Rice, Freyn vice president and general manager, recalled that in 1918 the industry hailed construction of the first furnace with a 20-ft hearth. It has taken 37 more years to cross the 30-ft line.

The new furnace rises 252 ft above the yard level. It rests on concrete pads 71 ft in diam and 16 ft thick, which, in turn, rest upon steel piling extending 84 ft into the ground to bed rock. Firebrick of various dimensions equivalent to 2,844,694 of the standard 9-in. size were used to line the furnace, its three hot-blast stoves and other auxiliaries. Total weight of the furnace when fully charged is 12,813 tons.

Details of the furnace are as follows:

Furnace No.	A
Diameter of hearth, ft-in.	30-3
Diameter of bosh, ft-in.	33-3
Diameter of stockline, ft-in.	23-0
Height, iron notch to top ring, ft-in.	110-0
Height of crucible, ft-in.	12-0
Height of bosh, ft-in.	11-3
Height of straight section, ft-in.	8-0
Height of inwall section, ft-in.	60-0 9/16
Height, stockline section to top ring, ft-in.	10-5
Height, bottom to iron notch, ft-in.	2-0
Height, iron notch to cinder notch, ft-in.	4-11
Height, cinder notch to tuyeres, ft-in.	3-9
Total interior volume	64,425
Working volume, tuyeres to stockline, cu ft	55,300
Bosh angle, deg-min-sec	82-24-20
Inwall slope, in. per ft	1.024
No. of tuyeres	24
No. of columns	8
Lining thickness, crucible, in.	36
Lining thickness, bosh, in.	27
Lining thickness, stack, in.	40 1/2
Lining thickness, throat, in.	45
Big bell diameter, ft-in.	16-6
No. of stoves	3
Stove diameter, ft-in.	26-0
Stove height, ft-in.	115-0
Checker openings, in.	2 and 2 5/8
Heating surface per stove, sq ft	237,500
No. of turbo blowers	1
Blower capacity, cfm	125,000
Blower pressure, psi	35

Construction of the furnace required ten months, with as many as 500 men working at one time during the peak construction stages. Some 90 employees are required to man the furnace and its auxiliary installations for three shifts.

The rated capacity of the new unit is 50,000 tons of iron per month, but as operating experience develops, engineers predict that the furnace may average over 60,000 net tons per month.

The new facility replaces a small furnace that was dismantled last year after 19 years' service. It restores to four the number of blast furnaces at Great Lakes Steel's Zug Island plant, which produces iron for the steelmaking operations in the main plant at nearby Ecorse. Total rated capacity of the four furnaces is 2,050,000 tons per year.

The additional supply of iron provided by the new furnace, plus enlargement and modernization of other facilities now in progress at the main plant, will enable Great Lakes to increase its output of cold-rolled sheet by 600,000 tons annually. This program is scheduled for completion later this year as part of the overall 1954-1955 program of expansion and improvement in the operations of National Steel Corp. which Ernest T. Weir, chairman, has stated will require a total expenditure in excess of $120,000,000.

At Great Lakes Steel's specifications, the new blast furnace was designed and built with every possible attention to elimination of air and stream pollution in its operation. Before vapors are released to the atmosphere, they are passed successively through a mechanical dust catcher, a washing system and electrostatic precipitators with 34,000 sq ft of electrode plates which hold dust and other solids until they are removed for re-use or for disposal. Water discharge lines are connected to the plant's system for removal of objectionable matter from water before it is emptied into the river.

An additional step to avoid air pollution is provided for in the gas bleeder system. This is the system that automatically relieves pressures should they get too high.

While in most blast furnaces with high pressure operation, any excess pressure that may develop is relieved by an automatic discharge of hot, abrasive gases, blast furnace "A" is designed to relieve the pressure through the discharge of gases which already have undergone cleaning processes.

At 100 per cent of rated operating capacity, the new furnace will use 3200 net tons of iron ore, 1300 net tons of coke, 550 net tons of limestone, 55,000 tons of cooling water, and 5000 tons of air. This requires 511 skip hoist trips or one about every 2.73 min in the day.

Charging of blast furnace "A" is completely automatic. It has a Freyn-design charging control system governing the sequences of skip lifts, the bell hoists, the equalizer and relief valves, revolving distributors, stockline recorders, the measurement and charging of coke, together with the handling of coke breeze. All this equipment is automatically operated, requiring no attention on the part of the operator other than manipulation of the pushbutton at the loading pit when initiating a charge.

Design of the new unit was based on that of Great Lakes Steel's furnace "D," a 28-ft hearth unit which was designed and constructed by Koppers during 1951 and 1952.

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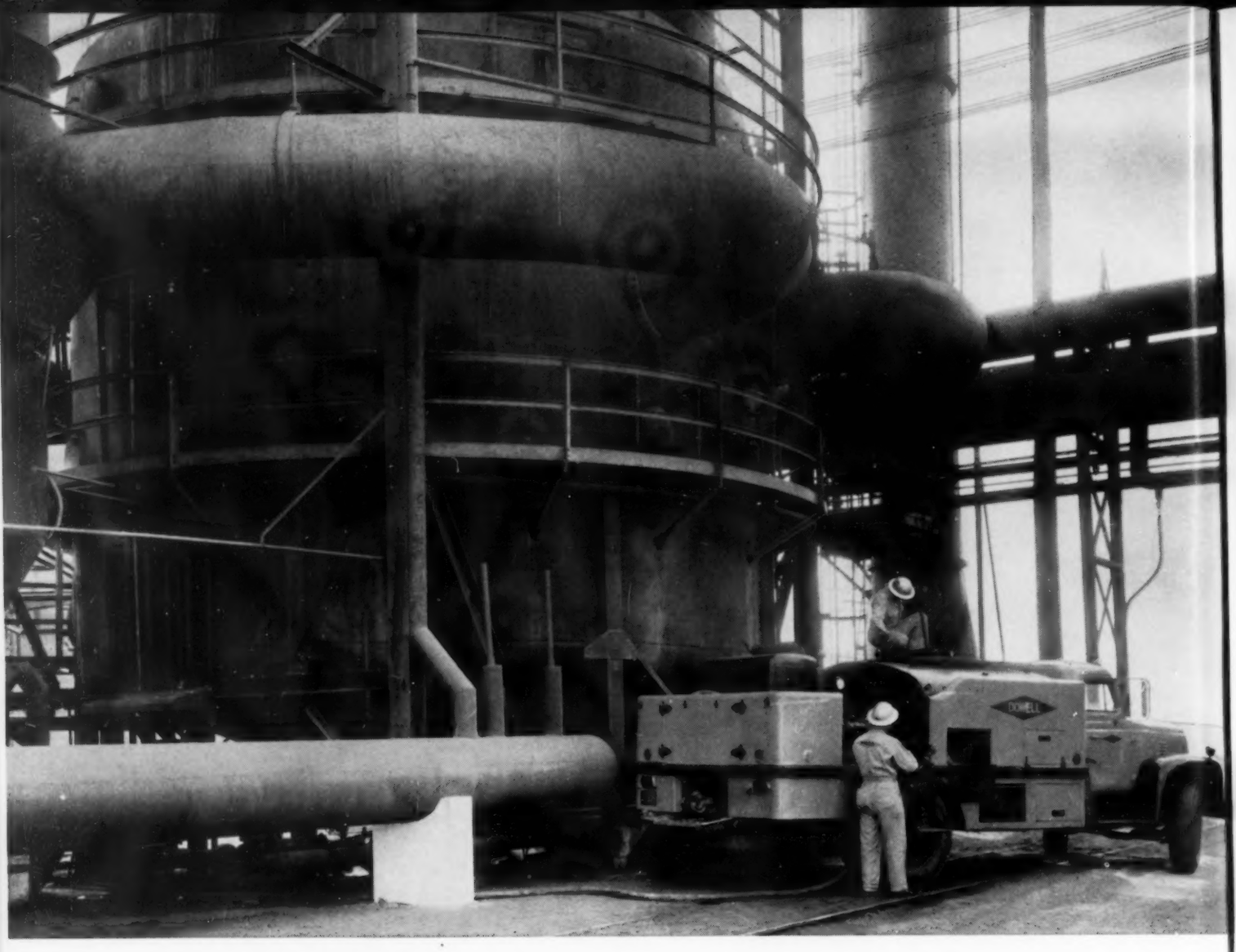

NO PRODUCTION SLOWDOWN DURING CLEANING

Without cutting gas output, DOWELL cleaned four precipitator sections chemically in only 15 hours—177 hours faster than mechanical cleaning

In today's steel plants, production schedules are more demanding than ever. Downtime may well spell the difference between profit and loss. That's one reason this operator was so pleased with Dowell chemical cleaning.

The operator had estimated that, using mechanical methods, it would take 192 hours to remove deposits from his four electrostatic precipitator sections. Dowell engineers, using chemical solvents, did the job in just 15 hours—saving 177 hours of valuable downtime. Inspection showed the sections to be free of scale and sludge. Moreover, no production was lost. Only a single section was taken out of service at any one time during the cleaning, allowing gas requirements to be met continuously.

With chemical cleaning, downtime is held to a minimum because solvents are introduced through regular connections. The liquid solvents used by Dowell go wherever water flows—cleaning all curves, angles and irregular surfaces.

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chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Date-line Diary...

May 2

▲ The AISI reports that operating rate of the steel industry for the week of May 2 is scheduled at 96.5 per cent of capacity. This is equivalent to 2,328,000 tons compared with 2,307,000 tons one week ago and 1,654,000 tons one year ago. Index of production for the week is 144.9.

▲ Bethlehem Steel Corp. has offered $191,659,000 of 3¼ per cent debentures with first chance to purchase going to common stockholders in the ratio of $500 of debentures for each 25 shares held.

May 3

▲ Benjamin F. Fairless has resigned as chairman and and chief executive officer of United States Steel Corp., having reached the customary retirement age of 65.

▲ Consumer installment credit was boosted by $466,000,000 as a result of heavy auto buying in March, the Federal Reserve Board reported, in comparison with a drop of $201,000,000 in March 1954.

▲ March employment in the iron and steel industry totaled 629,900 wage earners who averaged 41.1 hr a week in March compared with 40.0 in February at an average hourly rate of $2.385.

May 4

▲ Manufacturers' sales in March rose to a new high of $28,000,000,000 which topped a previous record of $26,800,000,000 in October 1953. The March sales were $3,400,000,000 over February 1955 and $2,700,000,000 above March 1954.

▲ According to the Federal Trade Commission and Securities and Exchange Commission, manufacturers' profits rose 18 per cent in the last quarter of 1954 over the 1953 last quarter.

▲ Roger M. Blough has been named Benjamin F. Fairless' successor as chairman and chief executive officer of United States Steel Corp.

▲ Birdsboro Steel Foundry Co. offered to purchase 80 per cent of each stockholder's shares at $20 per share.

May 5

▲ Barium Steel Corp. announced a net loss of $471,594 on sales of $12,914,118 for the quarter ending March 31, 1955 in comparison with a loss of $28,755 on sales of $12,385,293 for the quarter ending March 31, 1954.

▲ The Aluminum Association reported primary production of aluminum in March totaled 260,543,479 lb in comparison with 232,472,999 lb in February and 244,678,349 lb in March 1954.

▲ Individual income in March rose to a record annual rate of $294,200,000,000 or $1,800,000,000 above the previous high in February and $9,200,000,000 above the March 1954 figure.

▲ April production at Inland Steel Co. rose to a new high of 439,160 tons, slightly above the record set in March.

May 6

▲ Wholesale dealers were active in March with total sales of $9,700,000,000, the highest month since October 1953 and $1,200,000,000 above February 1955.

▲ High rigid price supports of basic farm crops during 1955-57 were voted by the House 206 to 201.

May 8

▲ According to the F. W. Dodge Corp., contract awards for future construction in the 37 eastern states in April reached a record-breaking total of $2,322,085,000 which was 37 per cent higher than April of 1954.

May 9

▲ Youngstown Sheet and Tube Co. began erection of new facilities at East Chicago, Ind. which will double present capacity to produce electrolytic tinplate.

▲ The AISI reports that operating rate of the steel industry for the week of May 9 is scheduled at 96.7 per cent of capacity. This is equivalent to 2,334,000 tons compared with 2,331,000 tons one week ago and 1,690,000 tons one year ago. Index of production for the week is 145.3.

May 10

▲ In Pittsburgh, three grades of open hearth scrap dropped $1 per ton for the second time this month. Such markdowns have also taken place in Chicago, Cleveland and Youngstown.

May 11

▲ The AEC has been asked by six utilities to approve the plans for a new $45,000,000 nuclear power plant southwest of Chicago. The new plant is expected to have a net electrical capacity of 180,000 kw.

▲ Pennsylvania Railroad's net income topped $11,000,000 in the first four months of 1955, the largest figure for this period in ten years. Last year had a loss of $3,300,000 for this four month period.

May 12

▲ CIO Steelworkers' executive board met in Pittsburgh to draft wage demands of the union.

▲ The Aluminum Association reported primary aluminum production in April totaled 252,788,467 lb in comparison with 260,543,479 lb in March and 240,867,314 lb in April one year ago.

May 13

▲ The CIO United Steelworkers, when asking for higher wages next month in their new contract talks, will meet with the six largest producers at the same time, a new procedure.

▲ The Government filed civil anti-trust suits against six major publishing and advertising associations

charging that they had entered into an agreement by which publishers would recognize only those agencies for credit and agency commissions.

▲ Inland Steel Co. will begin a five-year dredging project on the company's property near Atikokan, Ontario to enlarge its iron ore output.

▲ Bethlehem Steel Corp. has made its first shipment of iron ore from its Marmoro mine in Ontario, Canada.

May 16

▲ The AISI reports that operating rate of the steel industry for the week of May 16 is scheduled at 96.3 per cent of capacity. This is equivalent to 2,324,000 tons compared with 2,334,000 tons one week ago and 1,636,000 tons one year ago. Index of production for the week is 144.7.

▲ According to the Commerce Dept., national production of goods and services soared to a record annual rate of $370,000,000,000 in the March quarter, $14,200,000,000 ahead of the pace in the 1954 period.

▲ Inland Steel Co. will begin a multi-million-dollar construction program to increase steelmaking capacity at Indiana Harbor, Ind. by 200,000 tons yearly.

May 19

▲ The ARCI announced deliveries of new domestic freight cars in April totaled 2,750 compared with 2,833 in March and 4,038 in April 1954. Orders for 2,706 were placed in April leaving a backlog of cars on order as of May 1 totaling 17,930.

▲ The Business and Defense Services Administration published its first issue of a new magazine entitled "International Iron and Steel."

May 20

▲ Common stock financing for the March quarter rose to $760,000,000 in comparison with $460,000,000 for the like 1954 period, the SEC reported.

May 23

▲ The AISI reports that operating rate of the steel industry for the week of May 23 is scheduled at 96.3 per cent of capacity. This is equivalent to 2,324,000 tons compared with 2,338,000 tons one week ago and 1,698,000 tons one year ago. Index of production for the week is 144.7.

▲ According to the Labor Dept., unemployment compensation fell to 1,346,500 in the week ending May 7, down 53,000 from the preceding week and compared to a total of 2,124,600 for this period one year ago.

May 24

▲ CIO United Auto Workers voted to strike to gain benefits demanded from the company including the guaranteed annual wage, according to the head of the union's GM council, Mr. Jack Livingston.

May 25

▲ Aluminum shipments of the Reynolds Metals Co. were increased to an annual rate of 208,000,000 lb during the first quarter of 1955 compared with 160,000,000 lb in 1954.

▲ April machine tool orders dropped to $53,400,000, a $10,000,000 drop from March but was 26½ per cent above April 1954.

May 26

▲ The proposed merger between Bethlehem Steel Co. and Youngstown Sheet and Tube Co. would result in a steelmaking capacity of 28,500,000 tons only 10,000,000 tons below the leading steel producer, U. S. Steel Corp., since a 3,000,000-ton increase in capacity is contemplated if the merger goes through stated E. G. Grace, chairman of Bethlehem.

▲ Granite City Steel Co. declared a cash dividend on common stock of 35¢ a share.

▲ Benjamin F. Fairless has been elected president of the American Iron and Steel Institute with no salary after having retired from United States Steel Corp.

▲ Hendy International Corp. has placed a $25,000,000 order for 5 new ore ships from Deutsche Werft of Hamburg, Germany.

May 27

▲ According to the AISC, April bookings of fabricated structural steel amounted to 269,703 tons compared with 285,434 tons in March and 184,982 tons in April 1954. Shipments in April totaled 239,658 tons leaving a backlog of work ahead as of April 31 of 1,443,506 tons.

▲ Arthur B. Homer, president of Bethlehem Steel Co., predicted steelmaking capacity in the U. S. will increase 60,000,000 tons in the next 15 years bringing ingot capacity 50 per cent above its output today.

May 30

▲ The AISI reports that operating rate of the steel industry for the week of May 30 is scheduled at 96.7 per cent of capacity. This is equivalent to 2,334,000 tons compared with 2,326,000 tons one week ago and 1,674,000 tons one year ago. Index of production for the week is 145.3.

May 31

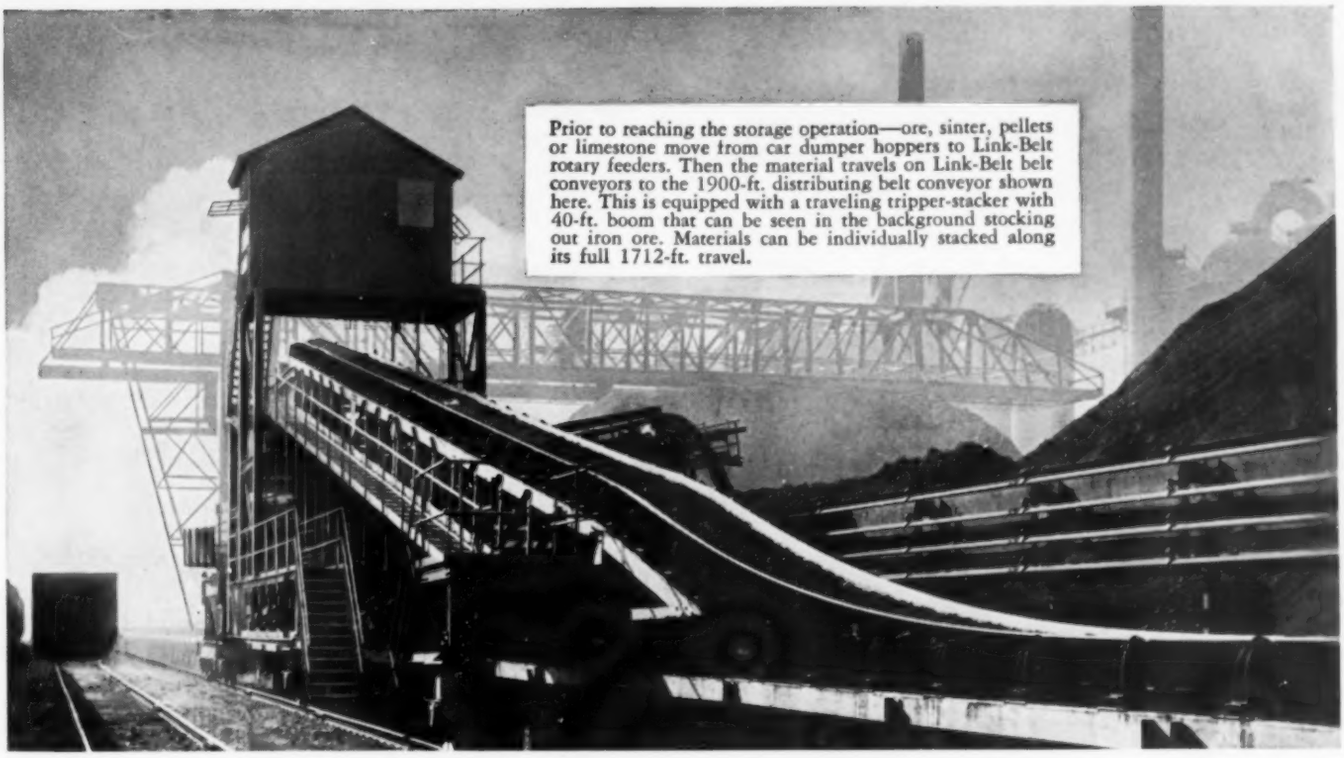
▲ Steel production in May will reach the highest monthly output in history at 10,325,000 tons which is 157,000 tons above its previous record in March 1953.

▲ Unemployment compensation claims fell to the lowest level in 19 months at 192,000 for the week ending May 21, off 14,100 from the previous week, according to the Labor Dept.

▲ The Commerce Dept. reported that U. S. exports of commercial goods fell to $1,100,000,000 in April, 10 per cent below April in 1954.

▲ The New York Central, the Nickel Plate and the Pennsylvania railroads are cooperating with the Pittsburgh Consolidation Coal Co. in the construction of the nation's first coal-hauling pipeline from the Cadiz, Ohio area to Eastlake on Lake Erie.

▲ Employment in the iron and steel industry rose 13,300 from March to a total of 643,200 in April. Working hours averaged 39.9 hr per week during April in comparison with 41.1 hr per week in March, at an average hourly payroll cost of $2.407. Total payroll in April was $282,025,000 compared with $288,229,000 in March.



Prior to reaching the storage operation—ore, sinter, pellets or limestone move from car dumper hoppers to Link-Belt rotary feeders. Then the material travels on Link-Belt belt conveyors to the 1900-ft. distributing belt conveyor shown here. This is equipped with a traveling tripper-stacker with 40-ft. boom that can be seen in the background stocking out iron ore. Materials can be individually stacked along its full 1712-ft. travel.

LINK-BELT accepts full responsibility for successful bulk handling operation

Read how LINK-BELT designed, built and erected unloading and storage facilities for large eastern mill

So satisfactory was the seven-year record of the Link-Belt coal handling system at this large steel mill, they again called on Link-Belt to modernize their other bulk handling. Now, from railroad car unloading to storage, Link-Belt has mechanized the movement of iron ore, sinter, pellets and limestone.

Link-Belt designed, built and erected the complete raw materials handling system for this mill—including such details as enclosures and electrical wiring. When you rely on Link-Belt as a single source, Link-Belt accepts full responsibility for placing your system in successful operation. Our engineers will also work with your own engineers, consultants and builders of mill and process equipment—help you get the best in modern handling of steel and raw materials in every form. For complete information, call the Link-Belt sales office near you.

Completely automatic Link-Belt rotary dumper easily unloads up to 30 hopper-bottom and gondola cars per hour.

Dual motor drive to head of 1900-ft. long conveyor employs Link-Belt 200-hp and 150-hp parallel shaft gear drives.

LINK-BELT

MATERIALS HANDLING, PROCESSING AND POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.534

You get longer life from charging boxes and peels cast in nickel UNIVAN steel

This special alloy steel has definite advantages over carbon steel. Due to its nickel content, for instance, UNIVAN has greater resistance to firecracking. And its high tensile strength provides greater resistance to torsional twist and shock.

So, if you're having trouble with excessive firecracking, distortion or breaking of your present castings, UNIVAN castings may be the answer to your problem—whether they be charging boxes, peels, bearing covers, couplings and spindles, tongs and tong levers.

We'll be glad to give you more information about the performance of UNIVAN castings on the toughest jobs. Or, if you want prompt service, just send us your blueprints for a quotation.

BLAW-KNOX

BLAW-KNOX COMPANY

Union Steel Castings Division . Pittsburgh 1, Pennsylvania

UNION PRODUCTS: charging boxes • peels • bearing covers • slag pots • tongs and tong levers • universal couplings and spindles • gears and pinions • ingot cars • charging box cars • special UNIVAN and ARMOR steel castings

DREVER VERTICAL
STRIP ANNEALING FURNACES

. . . for ferrous or non-ferrous metals

5 important advantages

1. VERSATILITY AND FLEXIBILITY
2. ABSOLUTE UNIFORMITY OF ANNEAL
3. MINIMUM FLOOR SPACE REQUIRED
4. HIGHLY ECONOMICAL AND EFFICIENT
5. ELECTRIC OR RADIANT-TUBE-GAS-FIRED HEATED

● *Illustrated are two 1820-KW, 20,000 lbs/hr Vertical Strip Continuous Annealing Furnaces for 42" wide strip.*

Write for Bulletin No. B-61

DREVER CO.

RED LION ROAD & PHILMONT AVE. • BETHAYRES, PA.

10

Instruments for Productive Maintenance

NEW G-E RECORDER, designated Type CH, has two modern styles in switchboard cases, in addition to the portable shown in operation above. Checking the efficiency of a lathe is just one of many applications of this new, versatile general purpose instrument.

REVOLUTIONARY WRITING SYSTEM ELIMINATES

New G-E Recorder Makes Clear Records Accurate and Easy to Read

NEW PLASTIC INKWELL holds full 3 ounces or triple amount of open kind. Comes sealed ready for insertion. You waste no time—spill no ink. After use—throw it away.

STURDY CONSTRUCTION of inking system combines fine writing qualities with extra long life. A highly polished, special alloy pen point reduces wear to a minimum.

GENERAL ELECTRIC ANNOUNCES . . .

NEW General Purpose Recorder

G-E RECORDER ASSURES LOW COST, PRECISE MEASUREMENTS, SIX BIG ADVANTAGES INCLUDE FIRST THROW-AWAY INKWELL

General Electric's new general purpose recorder is more serviceable, versatile, readable and durable than any other recording instrument available today—plus having the first throw-away plastic inkwell in recorder history. Charting a continuous record of an electrical quantity against time, different models of the new instrument can measure and record current, voltage, power, frequency or speed.

REVOLUTIONARY NEW inking system assures a clear, clean record and eliminates the problems of open inkwells found in all other recorders. The new G-E recorder provides six major benefits: Servicing time and costs are cut in half, spring clock runs up to 60 days, 28 different chart speeds are available, instrument is durably built for long life, records are easy to read, and maintenance is simplified.

FOR FURTHER INFORMATION, contact your nearest G-E representative, or clip and mail the coupon below.

Progress Is Our Most Important Product

GENERAL ELECTRIC

TROUBLESOME SERVICING OF OLD STYLE INKWELLS

SECTION C582-1
GENERAL ELECTRIC COMPANY
SCHENECTADY, NEW YORK

Please send me the colorful, easy-to-read bulletin GEA-6204 on the new G-E Recorder.

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Company.....

Street.....

City.....**Zone**....**State**.....

G-E RECORD ROLLS are 150 feet long and service is simple and easy. Handy side paper indicator tells quickly how much is left on paper roll, saves time, steps.

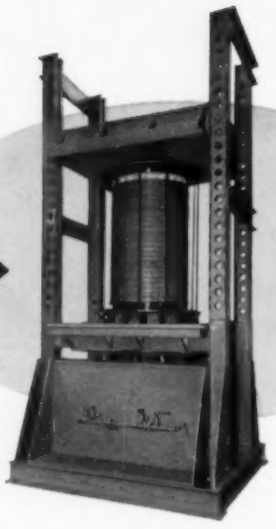
EASY-TO-HANDLE portable G-E instrument gives dependability throughout rough operations, as do other two models. Service, when needed, is quick and easy.

Over 15 years' experience in

"Putting on the Pressure"

is your proof that your

PENNSYLVANIA Power TRANSFORMER



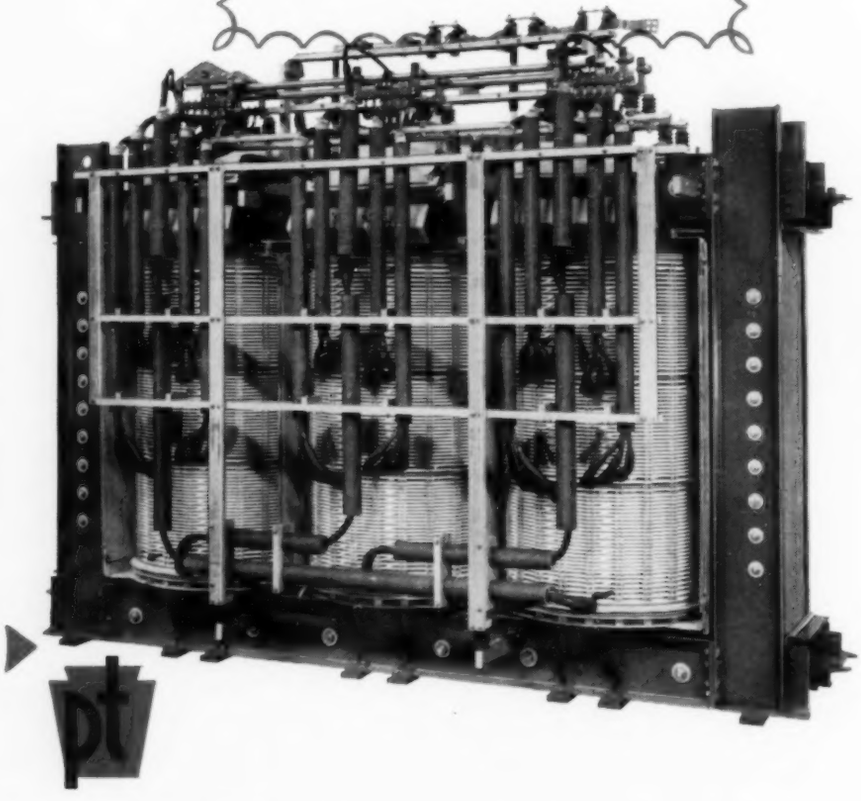
Pressures up to 600,000 pounds can be applied to coils by this Pennsylvania hydraulic press.

will withstand short circuits

When a large power transformer is subjected to a short circuit, a force of several hundred thousand pounds may be imposed axially on its coils. Of course, these short circuit forces are taken into account in the design of each transformer. But at Pennsylvania, "proof on paper" is not enough. Positive action is taken to be absolutely certain that your transformer will withstand short circuits. Putting on the pressure is the added measure of safety engineered into every helical and pancake coil. Pennsylvania engineers calculate the total short circuit force that would be produced by a short circuit at the secondary terminals with the rated voltage maintained on the primary. Each coil is then compressed with this predetermined force. Finally, the coil is treated in such a manner that it will maintain its compressed size and shape when mounted on the core.

This idea, as well as this method of precompressing coils, was devised by Pennsylvania Transformer Company over 15 years ago. It has been a regular step in Pennsylvania's manufacturing process ever since then.

The fact that the transformer coils maintain their shapes under the prescribed pressure is your guarantee that the transformer will withstand short circuits.



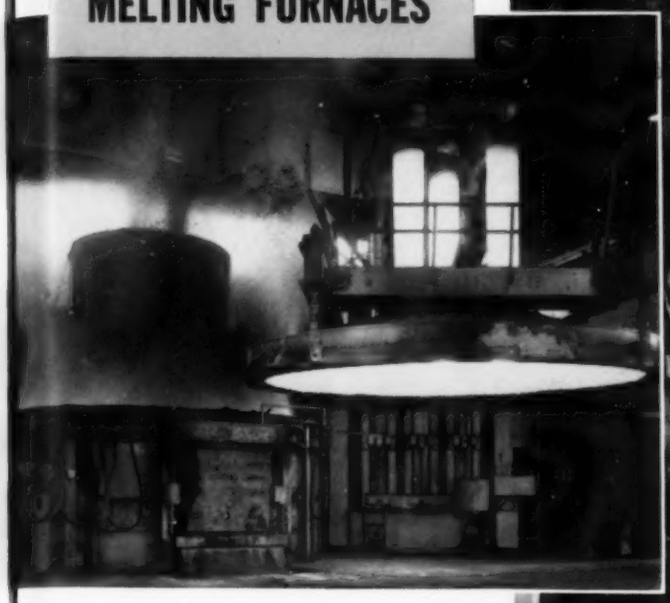
Core and coil unit of 20,000 Kva, three phase transformer. Strong supports are provided at the top and bottom of the coils to keep the coils in their precompressed shapes. No movement can take place in these transformer coils, even under the most severe short circuit.

PENNSYLVANIA TRANSFORMER COMPANY • **BOX 330, CANONSBURG, PENNSYLVANIA**

A McGraw Electric Company Division

Heroult
ELECTRIC MELTING FURNACES

TOPS FOR PRODUCTION OF HIGH GRADE STAINLESS, ALLOY AND RIMMING STEELS



World's Largest Electric Furnaces

. . . now in operation!

INSTALLED in the ultra-modern mill of McLouth Steel Corporation, in Detroit, these giant *200-Ton* Heroults are the largest electric melting furnaces ever built. With an inside shell diameter of 24'6", they have a rated charge capacity of 400,000 pounds, and each is designed for efficient operation on 25,000 to 33,000 KVA transformer capacity. Featuring a swing-type roof, these furnaces are equipped with the finest, most up-to-date mechanism and electrical controls available.

McLouth's adoption of electric furnaces of this size sets a precedent. It is a "first" which should conclusively prove that, in addition to closer control, higher uniformity, better performance, and greater safety, large capacity Heroult Electric Furnaces are an economically sound investment—even for high tonnage steel-making.

We welcome an opportunity to help you select and install the furnace best suited to your particular requirements.

ASK FOR NEW CATALOGUE. *Contains latest information on modern electric furnaces—types, sizes, capacities, rating, etc. Write Pittsburgh Office for free copy.*

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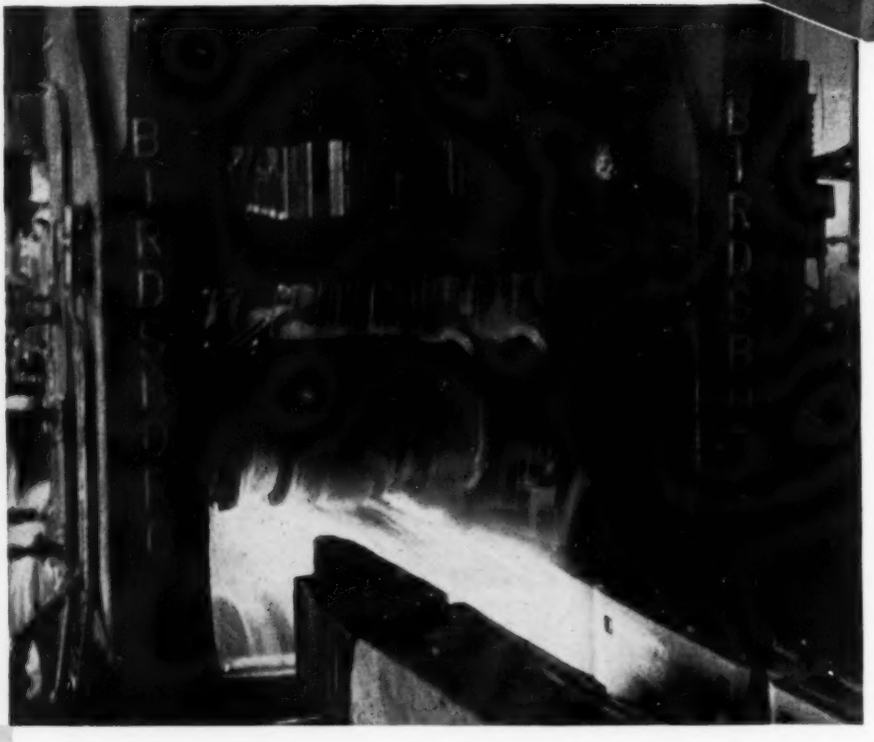
USS

UNITED STATES STEEL

Key to **FASTER PRODUCTION** from your Two-High Reversing Mills . . .

BIRDSBORO

alloy steel rolls



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STEEL MILL MACHINERY
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ROLLS: Steel, Alloy Iron, Alloy Steel

Gear your production to the outstanding performance of Birdsboro Alloy Steel Rolls . . . and see what a profitable difference it makes. Birdsboro is a recognized leader in designing and building both rolls and two-high reversing mills. That's why it pays to call in a Birdsboro roll specialist.

R13-55

BIRDSBORO

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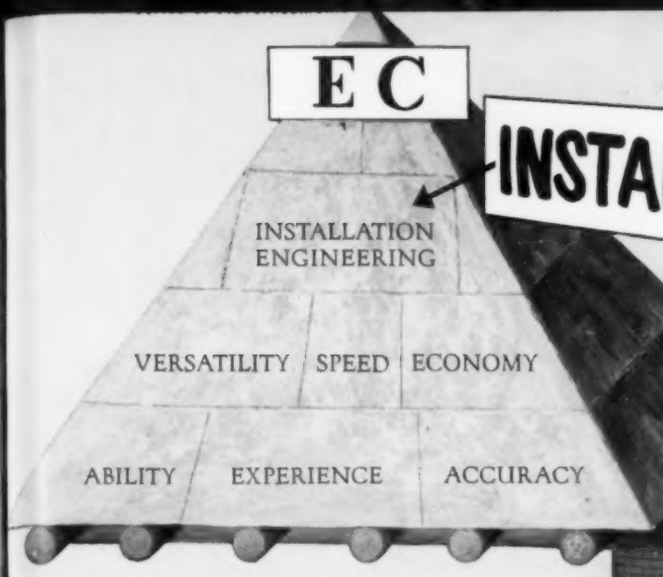
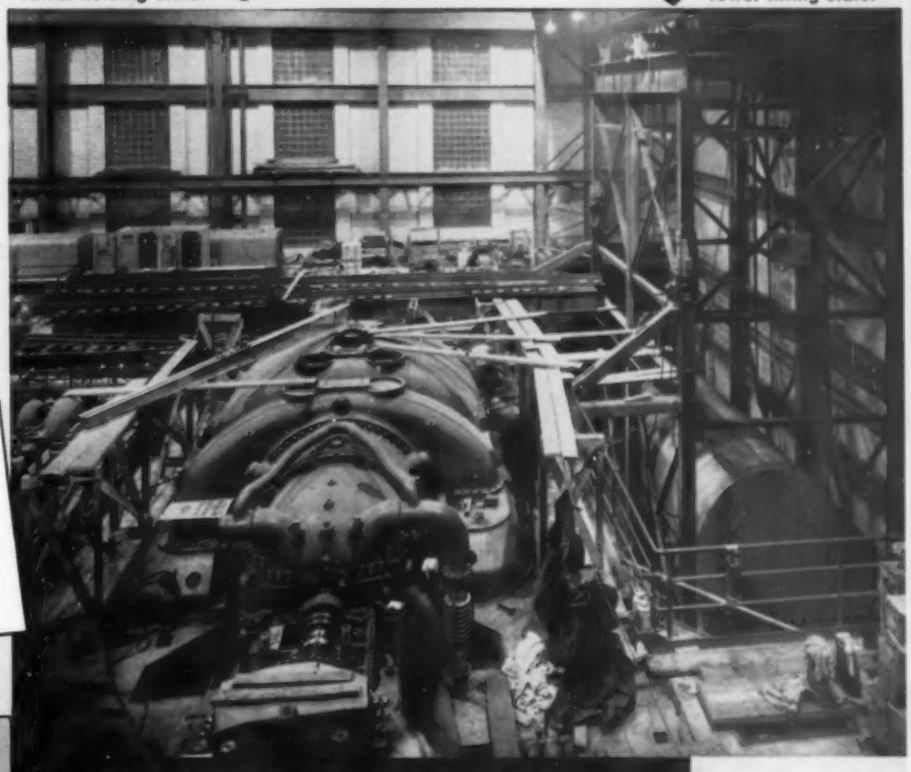
EC

INSTALLATION ENGINEERING



Tower holding Stator ⬆ ⬇ Tower lifting Stator



The installation engineering required to properly install a 197-ton stator typifies the application of knowledge and ingenuity with which the Eichleay Corporation approaches each machinery erection program.

Pre-planning for this project at the Delaware Station of the Philadelphia Electric Company indicated space limitations, low headroom, no overhead facilities of sufficient capacity and a necessity for lifting and moving the stator in one piece. The solution to all of these restrictions was the design, fabrication and use of a lifting tower. By using the tower the Eichleay Corporation performed one of its typical difficult installations in an expeditious, safe, and economical manner.

The Eichleay Corporation services are available for any industrial program and can be adapted to your special problem.

Eichleay Services

Industrial Installations
Construction of Heavy Foundations
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CORPORATION

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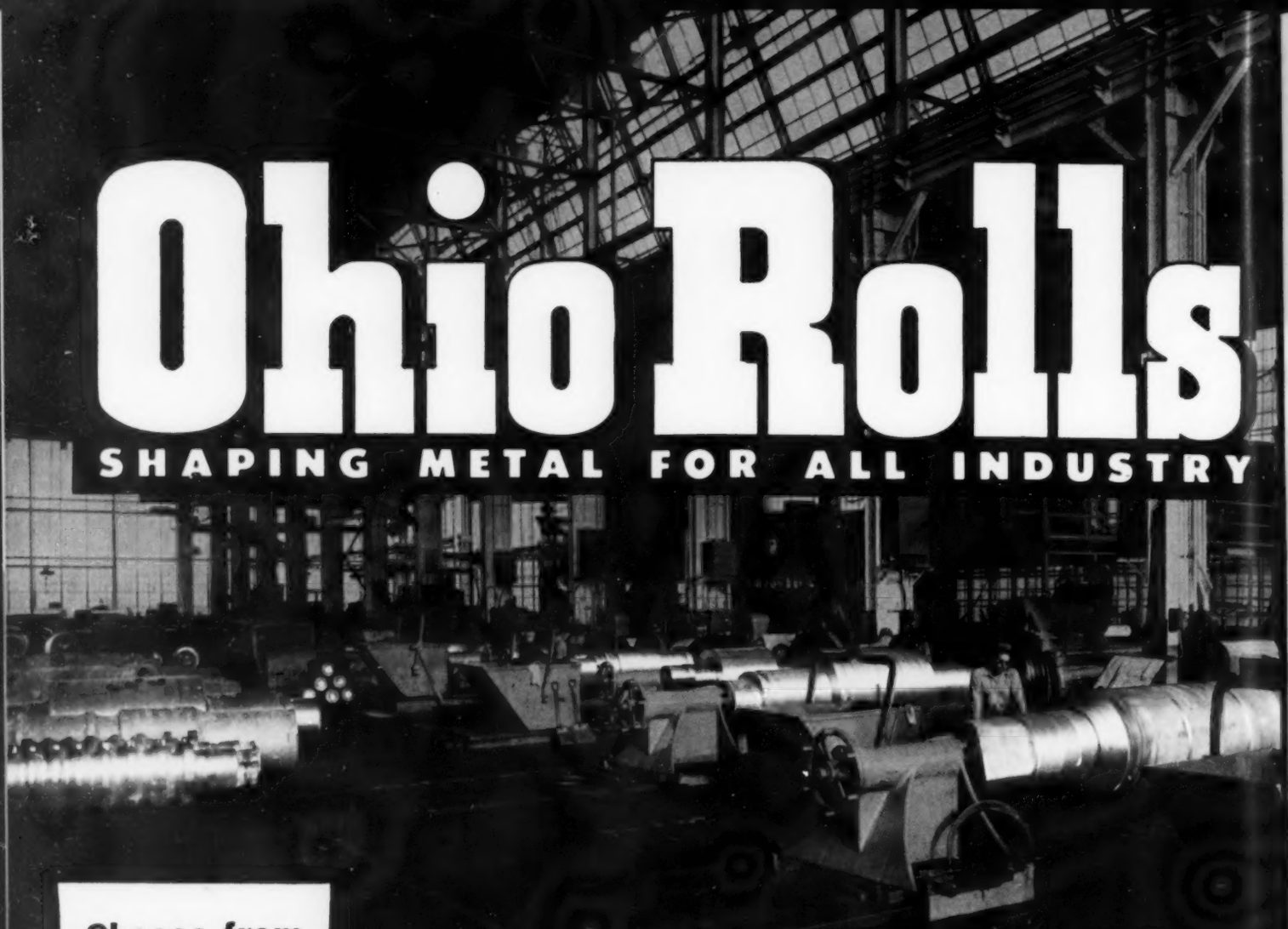
Ohio Rolls

SHAPING METAL FOR ALL INDUSTRY



Choose from 11 types of Ohio Iron & Steel Rolls:

- Carbon Steel Rolls
- Ohioloy Rolls
- Ohioloy "K" Rolls
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- Holl-O-Cast Rolls
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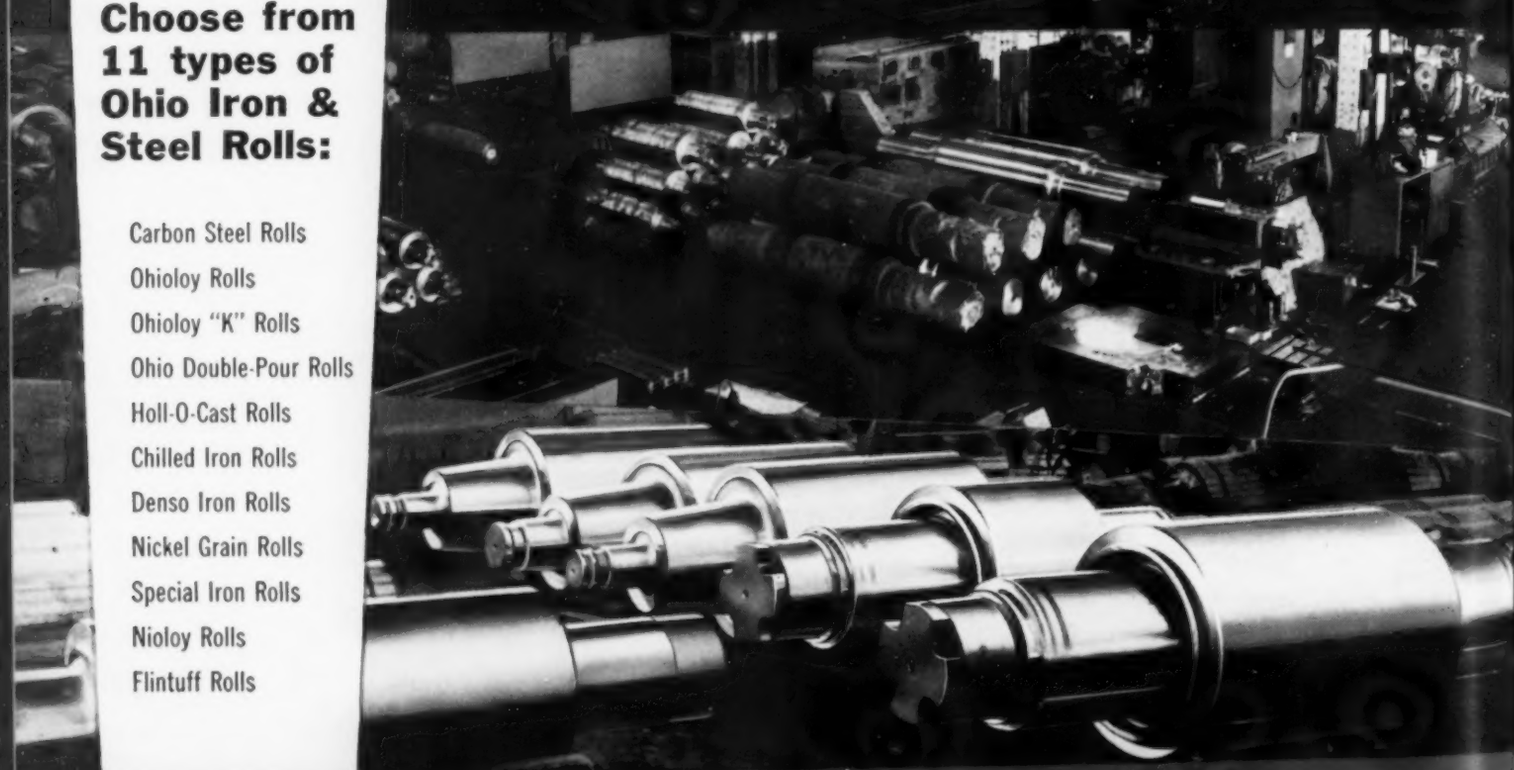
- Nickel Grain Rolls
- Special Iron Rolls
- Nioloy Rolls
- Flintuff Rolls



THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO • PLANTS AT LIMA AND SPRINGFIELD, OHIO

Industry News...

INLAND STEEL TO ADD SEVENTH BATTERY OF COKE OVENS AT INDIANA HARBOR WORKS

▲ A new multimillion dollar construction program at the Indiana Harbor Works of Inland Steel Co. has been announced.

Major item in the new series of expansion steps described by Joseph L. Block, president, will be the addition of a seventh battery of coke ovens and the accompanying by-products facilities.

Another 200,000 tons will be added to the plant's annual steelmaking capacity by early 1956. This is to be done through the installation of additional material handling equipment in one of its giant open hearth furnace shops and will bring its rated ingot capacity to 5,200,000 tons.

The increase will be the third achieved in consecutive years without construction of new steelmaking furnaces. In 1954, 300,000 tons was added and in 1953, 200,000 tons, in both cases by improvements in process, methods and equipment.

Contracts will be let soon for the building of a battery of 87 new by-product coke ovens. They are to have a capacity of 455,000 tons annually and will increase the company's coke-making capacity 21 per cent to 2,598,000 tons a year. Their output will replace coke now purchased and make the plant independent of outside sources.

Coal handling and storing facilities will also be expanded as well as facilities for producing and storing coal chemicals such as benzol, toluol, pyridine and sulphate of ammonia.

The coke plant additions are scheduled for completion within 18 to 24 months. The present six batteries contain 418 ovens and have a total capacity of 2,143,400 tons of coke a year.

New steelmaking capacity will be gained by installing additional and heavier equipment for charging material into the furnaces and tapping the molten steel in the plant's number two open hearth shop.

Faster handling of material and elimination of delays will account for the estimated 200,000 tons additional output annually. Use of oxygen to speed steelmaking and other improvements in techniques have shortened the periods between furnace tappings.

FLEXIBILITY KEYNOTES NEW CONTROLLER PLANT

▲ Despite all the great developments in mass production techniques, straight-line assembly methods and automation, many companies with large-scale production are still faced with the problem of maintaining complete flexibility in their plant layout.

That is the case with the Electric Controller & Manufacturing Co. and its new ultra-modern $4,500,000 plant just completed in one of Cleveland's outlying industrial areas.

In planning the new plant layout therefore, flexibility was the keyword. In future years, as designs change and product demands dictate, whole departments can be moved and the production flow completely altered at a minimum cost. Overhead space, utilities, hoisting facilities, even compressed air will be available wherever required.

The new one-story plant, which provides some 340,000 sq ft including office space, replaces half a dozen multi-story structures built or acquired during the last 50 years in what is now a highly congested industrial area.

Representing a floor space increase of some 63 per cent, the new structure is located on a spacious (27 acre) site adjacent to a residential area, and its trim architectural design of brick and aluminum sheathing, as well as its extensive landscaping, were carefully planned to blend with the suburban atmosphere. Ample parking facilities and access roads were provided to avoid traffic congestion in the area.

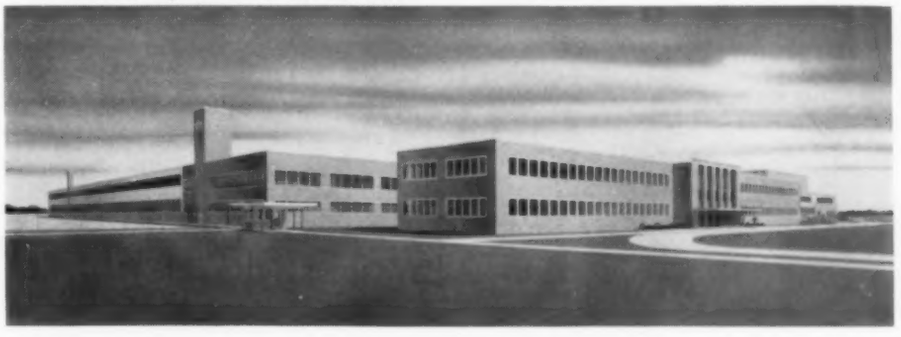
FLOW OF PRODUCTION

Receiving docks are at the northwest corner of the plant and shipping

'QUAKE-PROOF

Final unit in an order for three 100,000-kva "Contour Design" shell form power transformers awaits shipment at Pennsylvania Transformer Co.'s plant in Canonsburg, Pa. Designed to withstand earthquake shock, both the tank and the core-and-coil assembly are engineered to resist earth tremors and other violent shocks. Despite its large capacity, the 100,000-kva, 132,000 volt transformer will be shipped completely assembled except for bushings, cooling equipment, and other external accessories.

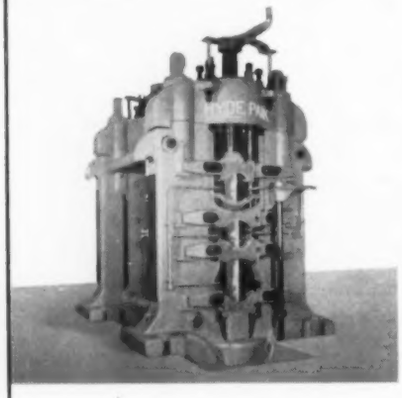
Planned for long range as well as immediate operating requirements, the new EC&M plant in southeast Cleveland, Ohio, affords flexibility for future expansion or alteration.



Hyde Park
RED CIRCLE Rolls ALLOY-CHILLED

Rolling Mill Equipment

For more than 50 years Hyde Park Steel Mill equipment has been helping American industry lead the world—equipment such as—



Bar Mills
Merchant Mills
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Machine Work

For finer finish, long life and greater tonnage, specify Red Circle Rolls.

Hyde Park
FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland Co., Pa.
ROLLS
ROLLING MILL MACHINERY
GREY IRON CASTINGS

Clearance from floor to bottom of trusses is 18 ft, except in this 50 x 450 ft, high-bay area where electric lifting magnets are produced. Here clearance is 22 ft under the crane hooks.

docks at the northeast corner. Flow of production follows 5 main routes, the company's products being generally classified into 5 principal categories: (1) lifting magnets, (2) brakes and limit switches, (3) motor starters, (4) magnetic controllers, and (5) resistors and master switches.

Routing of the heaviest product (lifting magnets) follows an almost straight path between receiving and shipping docks, while the other product lines fan out further into the plant, depending upon the size, weight and ease of handling of the products involved. The longest routing is that for small resistors and master switches.

The screw machine and milling machine departments are next to the receiving department to shorten the movement of bar stock and castings. The drill press department is adjacent to milling because of the large interchange of jobs between these two departments.

In the finishing department are the latest and most modern facilities for de-greasing, cleaning, phosphetizing, cadmium plating, spray painting and bake enameling. Capacity of the department is substantially larger than that in the old plant.

TEST TOWER

One of the features of the research and development facilities is a 55-ft high tower for the testing of electric hoist control equipment. This tower, which is 8 x 12 ft, has extensive equipment for the thorough investigation of alternating and direct-current hoist control problems and for experiments with all types of hoist circuits. Horizontal sliding windows at the mezzanine level allow clear vision to activity in the tower.

INSTALLS GIANT SLAB REHEATING FURNACES

▲ Erection of one of the world's largest slab-reheating furnaces has been started at the Weirton Steel Co. plant in Weirton, W. Va., as part of an extensive modernization of the continuous strip mill at Weirton.

The three new furnaces, being built by Surface Combustion Corp. will each have a normal capacity to reheat 200 tons of steel slabs to rolling temperature per hour.

Each of the new furnaces is about 118 ft long and wide enough to heat slabs that are 26 ft long.

NEW BAR AND ROD MILL INITIATES EXPANSION

▲ Atlantic Steel Co. broke ground May 17 for a new $8½ million merchant bar and rod mill.

According to R. S. Lynch, Atlantic's president, this new mill is the first phase of modernization and improvement program currently underway, and will substantially increase the company's productive capacity and product range. General engineer for the construction of the buildings and installation of the new mill is Rust Engineering Co.

The mill equipment will be housed

in a building 740 ft long by 100 ft wide. Two warehouses attached to the main building will occupy an additional 52,000 sq ft of space. The mill is expected to be completed and in operation by September, 1956.

Other features of the company's modernization program include a second electric furnace and a new administration building.

TO BEGIN CONSTRUCTION OF SEAMLESS TUBE MILL

▲ Work is scheduled to get underway shortly on a new seamless tube mill at the Indiana Harbor Works of the Youngstown Sheet & Tube Co.

Pipe produced in the new mill will range from four and one-half to nine and five-eighths in. outside diameter.

J. L. Mauthe, president of YS&T, said that the new mill was another step in rounding out the company's tubular development program in the Chicago district. The firm's present tubular facilities in the area include two continuous butt weld pipe mills, which produce pipe ranging from one-half to four in., an electrical weld mechanical tubing mill and a conduit department.

The new seamless facilities will consist of two main buildings 2,000 ft long to cover more than 400,000 sq ft. They will be located north of the new blooming mill and open hearth department and have been designed to make possible future expansion. Each of the two buildings will house both hot working and complete finishing and heat treating facilities. An emphasis will be placed on efficient and low-cost materials handling. Features of the new seamless mill will be precision rolling and finishing equipment.

HEPPENSTALL CO. OPENS NEW BRIGHTON PLANT

▲ Greatly enlarged and improved facilities for the design and manufacture of materials handling equipment have been placed in service by Heppenstall Co.

These operations, which until recently occupied a portion of the company's main plant in Pittsburgh, have been transferred to New Brighton, Pa., where a former forgings plant has been virtually rebuilt for this purpose.

HERE'S THE USG® BRUSH THAT DOES AN OUTSTANDING JOB ON ALL YOUR MILL MOTORS

When you replace the brushes on your mill motors, you can get the best results with U S G Grade 135 Brush with Statite®. For brushes that give superb results in other applications, see below. Write for your copy of the complete U S G Brush catalog today.

A typical U S G Grade 135 Mill Motor Brush with Statite*

U S G Grade 223 Brush for DC crane motors with Statite*

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U S G Grade 1658 Brush for tin line collector rolls

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*Permanent shunt connection, needing no hammerclips; cannot be jarred loose or pulled out.

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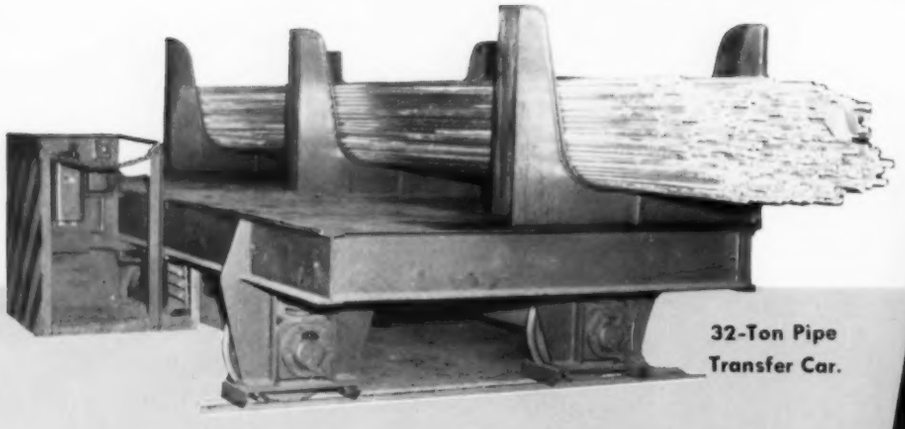
THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

SIMPLIFIED *Safety Type* TRANSFERS



32-Ton Pipe Transfer Car.

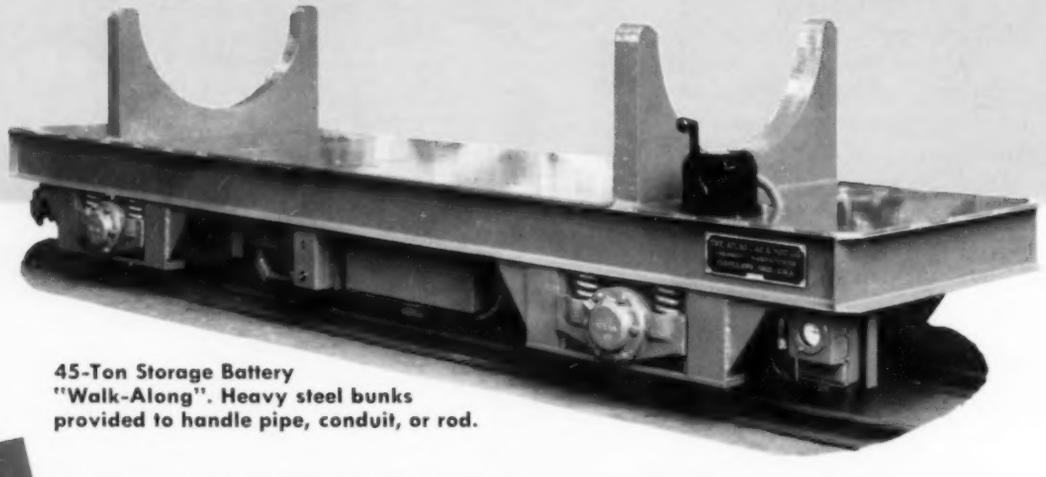
- STORAGE BATTERY Walk-Along or Rider-Type
- GAS-ELECTRIC
- DIESEL-ELECTRIC
- CABLE REEL . . . AC
- CABLE REEL . . . DC
- CABLE REEL . . . AC with fluid coupling

Also remotely controlled cars without trailing cable.

- Atlas Transfers are controlled by one lever. When the lever is released the car stops. This simplicity assures safety so that no assigned operator is necessary.

SAFE because there is only *one* control lever.

SAFE because the car will move *only* when the operator holds the lever.



45-Ton Storage Battery "Walk-Along". Heavy steel bunks provided to handle pipe, conduit, or rod.

Ask for "Walk-Along" Bulletin 1283 for complete transfer car information.

Manufacturer of Ore Transfer Cars • Scale Cars • Coal Charging Cars • Coke Quenching Cars • Coal and Metal Mining Storage Battery Locomotives.

THE ATLAS CAR & MANUFACTURING CO.

1100 IVANHOE ROAD **CLEVELAND 10, OHIO**

The new plant includes a manufacturing building, covering more than 60,000 sq ft, and a two-story office building in which quarters are provided for the engineering and sales departments of the materials handling equipment division.

INSTALLS PATENTING FURNACE AT ROEBLING

▲ A new patenting furnace has been installed at the Roebling, N. J., works of the John A. Roebling's Sons Corp. Installed in the steel wire mills division galvanizing shop, the new furnace has already undergone successful test runs.

The new installation coupled with a galvanizing furnace makes for a highly versatile and flexible unit providing for four basic types of operations. The furnace will add important new production facilities expediting the efficient manufacture of a wide variety of wire and wire products.

Installation of the new furnace involved the razing of a 20 ft sq brick stack 80 ft tall, and replacing it with two modern steel stacks. Razing of the old stack resulted in a clear bay 22 ft by 240 ft where the new furnace was built. All noxious fumes are eliminated from the work area by means of exhaust fans in hoods extending over both the lead pan and the acid tank.

OPENS PURCHASING HEADQUARTERS IN N. Y.

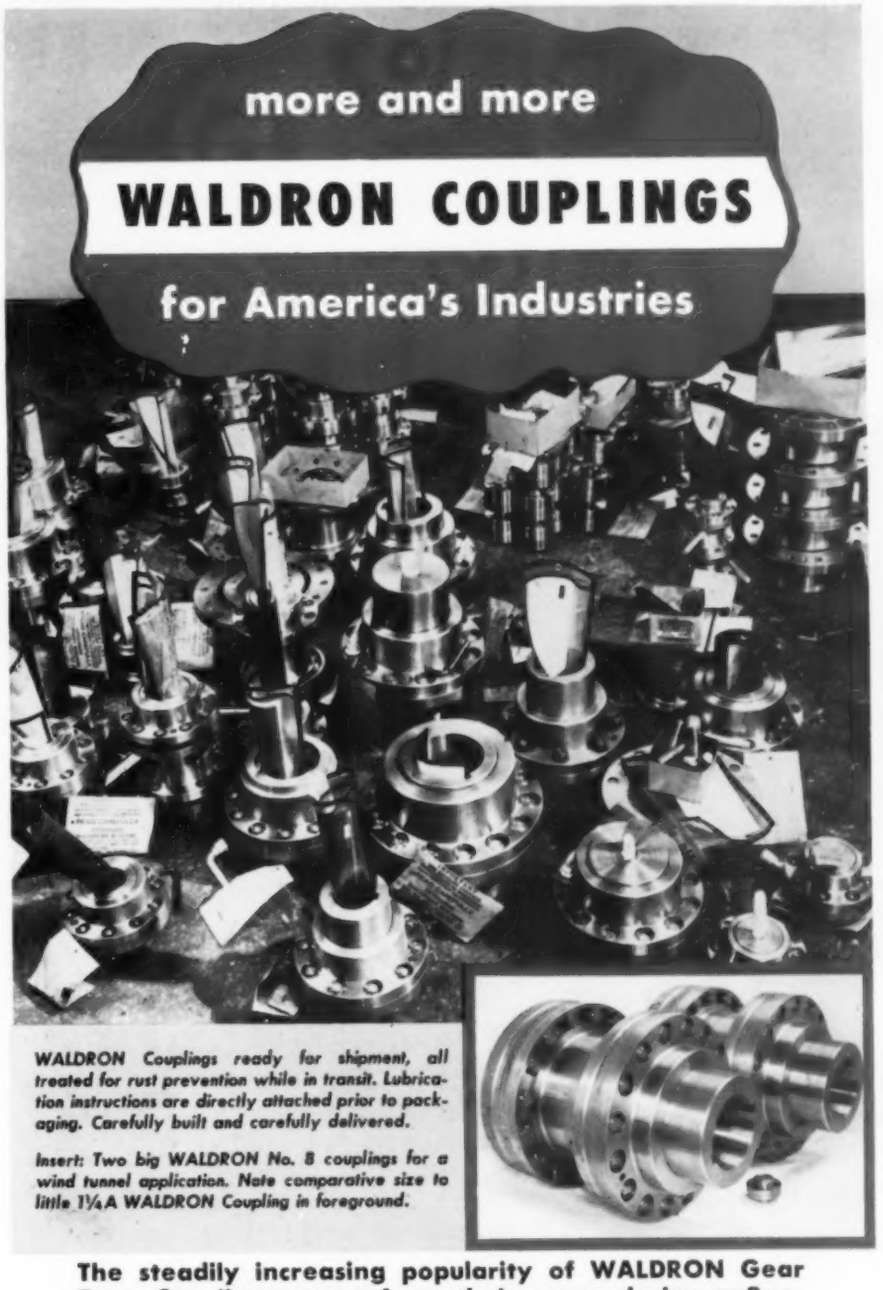
▲ Vanadium Corp. of America recently opened purchasing headquarters at the company's executive offices, 420 Lexington Ave., New York.

Director of purchases Frederic W. Thomas, newly appointed assistant director of purchases Arthur G. Paugh and their staff now are located at this address.

REPUBLIC ADDS SOAKING PITS AT BUFFALO PLANT

▲ Work began last month on a block of four new soaking pits at the Buffalo plant of Republic Steel Corp.

Each of the new pits will be able to heat at one time 14 ingots of steel weighing approximately six tons each. Installation of the new block



WALDRON Couplings ready for shipment, all treated for rust prevention while in transit. Lubrication instructions are directly attached prior to packaging. Carefully built and carefully delivered.

Insert: Two big WALDRON No. 8 couplings for a wind tunnel application. Note comparative size to little 1¼A WALDRON Coupling in foreground.

The steadily increasing popularity of WALDRON Gear Type Couplings stems from their many design refinements, sturdy construction and operating advantages which combine to insure their longer service life. Year after year, more and more users find a WALDRON Coupling the most economical to buy. They are first choice today of leading equipment builders. Write for literature describing various types.

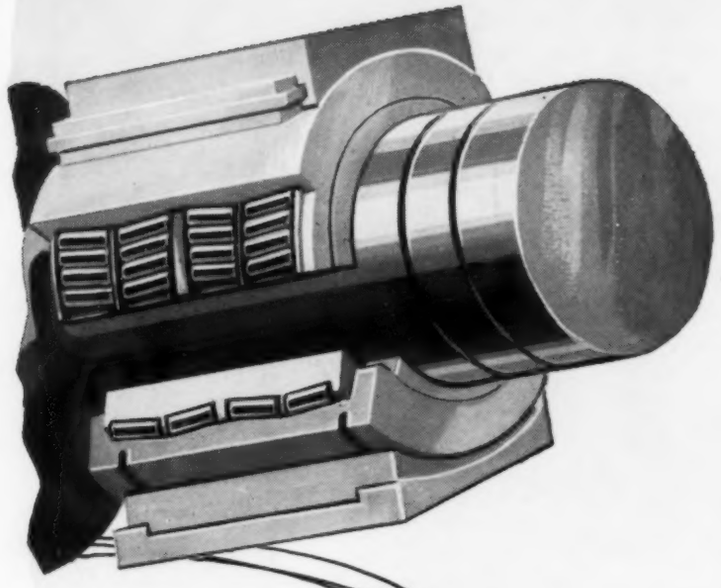
STANDARD • HEAVY DUTY MILL • SHEAR PIN • CUT-OUT
FLOATING SHAFT • SPACER • OIL COLLECTOR • SPECIAL TYPES

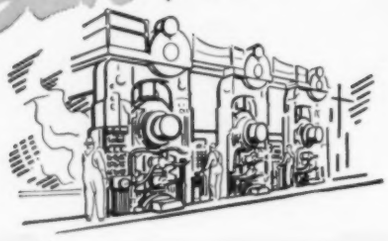
WALDRON couplings are available in sizes up to 18" shaft diameter. We specialize in furnishing couplings for unusual applications and services. We would be pleased to send you our latest bulletin 55 upon request.

JOHN WALDRON CORPORATION
New Brunswick, N. J.
Since 1827

Sales Representatives In Principal Cities

FOR SEVEREST ROLLER BEARING SERVICE





BROOKS * LEADOLENE 375

*THE I.P. LUBRICANT WITH *Indestructible pH-ilm*

Brooks Leadolene 375 provides safe, trouble-free lubrication of roller bearings under heaviest loads, overloads and severest shock conditions, such as experienced in heavy duty work roll service on 4 high hot strip mills, reduction mills and temper pass mills. Developed through years of research, this modern industrial lubricant provides corrosion resistance to component parts of bearing from cooling water and other contaminating actions.

Available in three grades . . .

Leadolene 375 Light: For normal or moderately high temperatures, with repellence of water a dominant factor. Excellent pumpability.

Leadolene 375 Medium: For heavier load and higher temperature requirements. Prevents leakage through seals. Excellent pumpability. Affords year around service under all temperature conditions.

Leadolene 375 Heavy: For pressure gun or system applications in normal or high temperatures. Good pumpability.

A Brooks lubrication engineer will gladly call at your request. Write, phone or wire today.

THE BROOKS OIL COMPANY
934 Ridge Avenue
Pittsburgh 12, Pa.

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The Brooks Oil Company

Since 1876

Executive Offices and Plant, Cleveland, Ohio
Executive Sales Offices, Pittsburgh, Pa.
Canadian Offices and Plant, Hamilton, Ontario
Cuban Office, Santiago de Cuba
Warehouses in Principal Industrial Cities

will balance out operations at the plant by increasing production on the blooming mill and increasing shipments.

The Buffalo plant has six other blocks of soaking pits. The new facility will provide approximately double the capacity of the old Number 7 block which it will replace.

WESTINGHOUSE APPOINTS CLEVELAND DISTRIBUTOR

▲ The Strong, Carlisle & Hammond Co. of Cleveland, Ohio, has been appointed a distributor for Westinghouse industrial fans, ventilating sets and unit heaters. The announcement was made by J. C. Thompson, sales manager of Westinghouse Electric Corp.'s Sturtevant Division.

Headed by C. R. Feldmann, the Strong, Carlisle & Hammond Co., have been distributors of a broad line of industrial products since 1887. Their distribution area covers the northern half of Ohio.

EXPANSION PROGRAM ANNOUNCED BY DE LAVAL

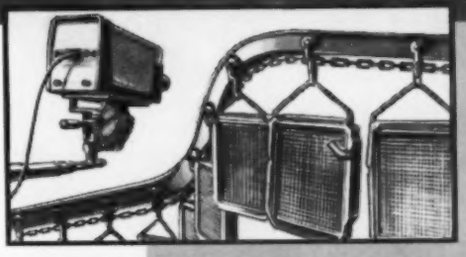
▲ An extensive long-range expansion program has been announced by the De Laval Steam Turbine Co. Under this program, land has been purchased for future construction of new buildings anticipated in Trenton, N. J. and Houston, Tex. In addition, specific building plans are already underway on land sites acquired near Chicago, Ill. and San Francisco, Calif.

Specific expansion plans involve land recently purchased adjacent to the existing De Laval plants in Trenton. Part of this area is already occupied by a building for the manufacture of high pressure turbochargers for diesel and gas engines.

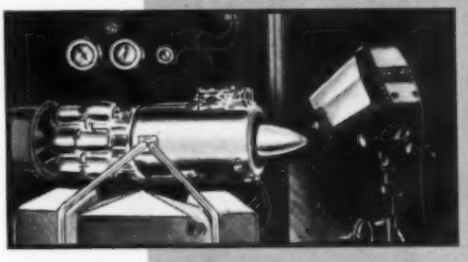
Another new building has been planned for erection in Forest Park, Ill. It will be occupied by the sales and service division for De Laval's operations in the midwest.

A new plant of about 40,000 sq ft is scheduled for Millbrae, Calif., near San Francisco. It is now under construction and is scheduled to be completed by August. It will house the sales and service facilities of the De Laval Turbine Pacific Co., a wholly-owned subsidiary.

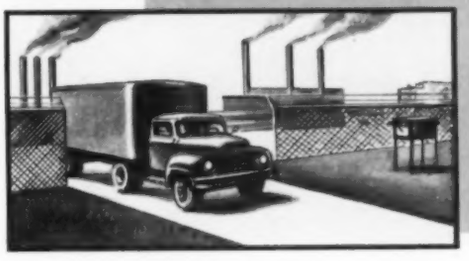
LET DIAMOND UtiliVue
INDUSTRIAL TELEVISION SYSTEM
Do the "WATCHING and WAITING"



"UtiliVue"—Industrial Wired Television can solve the problem of coordinating conveyor loading to avoid pile-ups and lost time. Any number of points may be watched simultaneously.



Processes which are too dangerous for direct observation may be watched safely by "UtiliVue". This includes destructive tests of machines, tests of explosives, atomic operations, etc.



"UtiliVue" cameras are available in weatherproof housings which enable one guard to watch several entrances at the same time. This is particularly useful for remote, infrequently used entrances.

Many plants have "watching and waiting" jobs scattered around . . . jobs where a man doesn't do anything except watch an operation and report at intervals to a person elsewhere.

The Diamond "UtiliVue" (wired television) can do the watching and waiting, releasing manpower for more productive work. It will watch any process . . . no matter how remote, dangerous or inaccessible . . . and bring a clear image to the observer. It enables him to SEE simultaneously and to coordinate several scattered but related jobs . . . an advantage obtainable in no other way. There can be no mistakes in communications. Get all the facts. Get in touch with your Graybar Distributor or use the coupon below.

7118

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FIRST IN INDUSTRIAL TELEVISION
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OFFICES IN 39 PRINCIPAL CITIES
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Since 1903, Diamond has Manufactured Quality Equipment for Industry

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Please send me without obligation a copy of new bulletin showing how Diamond Industrial (Wired) Television will help me reduce costs, improve quality, increase sales and aid safety.

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Company_____
Address_____

In Houston three acres have been purchased to accommodate, eventually, a new building planned for the sales and service of De Laval products in the southwest region, an increasingly important market for De Laval products, particularly the pipeline compressor for the natural gas transmission industry.

The first announcement of the company's expansion program, was made on the occasion of the firm's fifty-fourth anniversary as a tribute to the founder, Dr. Carl De Laval.

DIVISION TO BECOME STRAN-STEEL CORP.

▲ The Great Lakes Steel Corp.'s Stran-Steel Division, Detroit, Mich. will become a separate corporate unit of National Steel Corp. on July 1. The unit will be known as Stran-Steel Corp.

The announcement was made by Ernest T. Weir, board chairman for National Steel Corp. Mr. Weir said the change is being made to coordinate Stran-Steel sales, manufacturing and engineering activities as part of a program to expand this section of the business on a nation-wide basis.

Directors of the Stran-Steel Corp. will be Mr. Weir; T. E. Millsop, president and Paul E. Shroads, senior vice president of National Steel; Paul Carnahan, president of Great Lakes Steel, and C. LeB. Homer, president of Stran-Steel.

In an accompanying announcement, Mr. Homer said Stran-Steel is expanding its national sales organization by increasing personnel and establishing new zone offices in five cities—Atlanta, Ga., Cleveland, Ohio, Houston, Texas, Kansas City, Mo. and Minneapolis, Minn.

OIL RECOVERY INCREASED WITH NEW RUST SYSTEM

▲A specially designed system for the recovery of light oil from coke oven gas, recently installed at the Midland, Pa., Works of Crucible Steel Co. of America, has increased recovery more than ten per cent using only one of two existing absorption towers.

This report, based on the first month's experience with the system, was released by Crucible Steel Co. and the Rust Engineering Co., designers of the new recovery process.

Crucible's previously used absorption facilities consisted of two towers, each approximately 14 ft inside diam × 100 ft high, operating in parallel. Each tower contained six sections packed with steel turnings.

Due to excessive pressure drop, the two towers could not handle all of the gas produced when the coke ovens were in full production. Other factors considered when designing the new process were the low concentration of liquid hydrocarbons in the gas, and the large volume of coke oven gas, averaging 36 million cu ft per day.

Using only one of the towers and converting it to a spray type absorber, Rust designed and engineered a scrubbing system uniquely suited to the recovery of light oil.

The desired intensity of contact is obtained in the new system by circulating the oil at a high velocity with pumps. The savings in horsepower required to carry the coke oven gas through the modified absorption tower compensates for the horsepower required to operate the oil circulation system. A simple, highly effective

(*Please turn to page 174*)

Shenango
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POST OFFICE BOX 120
NEW CASTLE PENNSYLVANIA
DIVISION OF SHENANGO CHINA, INC.

Custom made special shapes
built to your specifications
Our engineering experience
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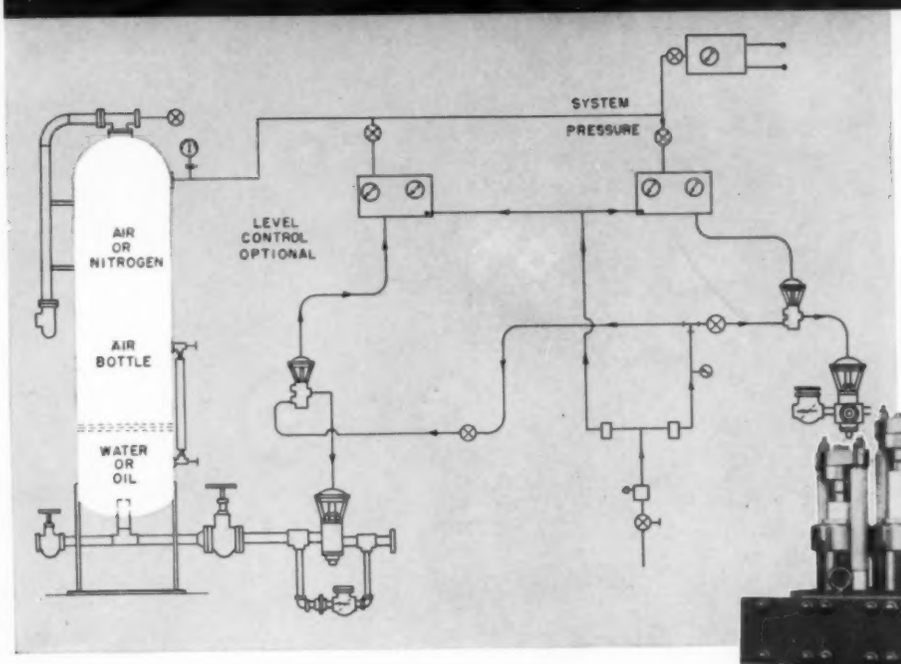
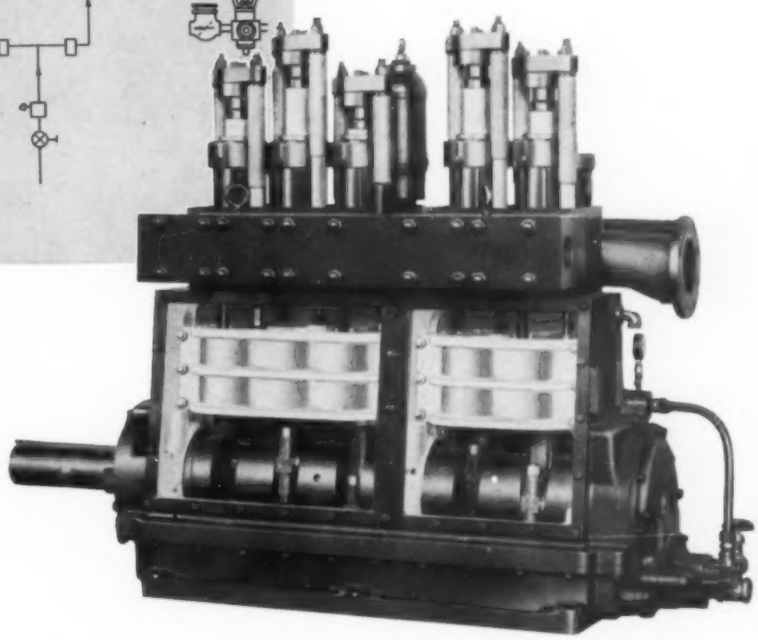


One source of hydraulic power instead of many . . .

minimum investment
less maintenance and repair
greater efficiency
lower operating cost



Aldrich central hydraulic systems . . . for oil or water

A single, concentrated source of efficient hydraulic power is wise economy and sound engineering. A single Aldrich Pump can supply all your presses and equipment—at a considerable saving. And if fire is a hazard, remember Aldrich design permits pumping *either* oil *or water*. Pumps are built in 2½", 3", 5", 6" and 8½" stroke, ranging from 25 to 2500 hp. Aldrich Pumps are integral parts of complete Aldrich Central Hydraulic Systems—designed to suit your needs and built to exacting standards

the ALDRICH *pump company*

. . . Originators of the Direct Flow Pump

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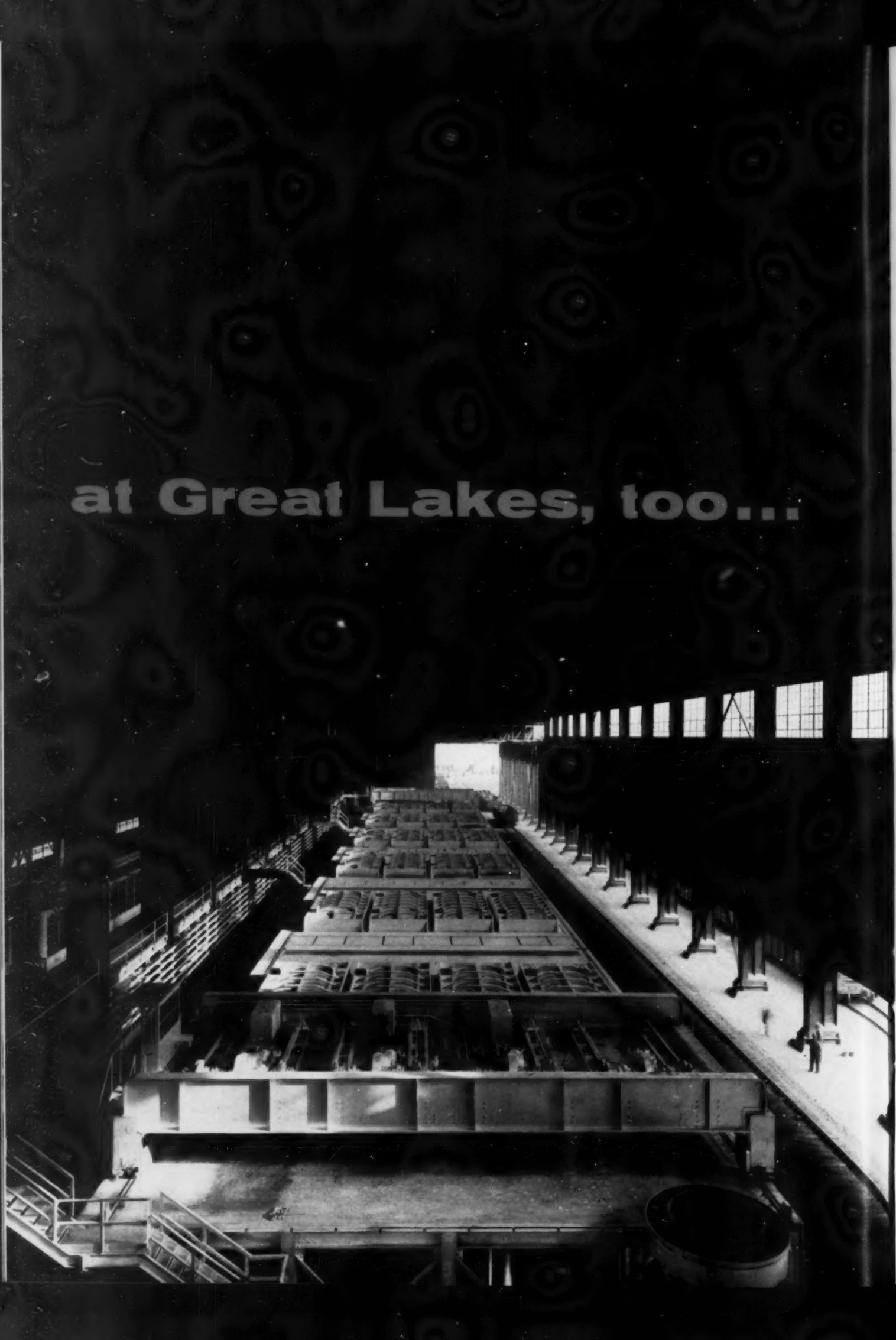
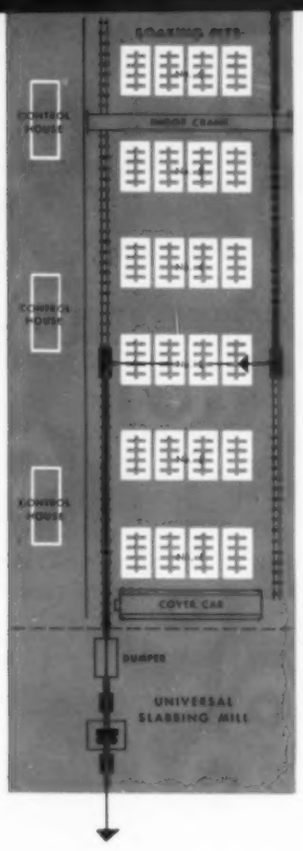
at Great Lakes, too...





high-production soaking pits

. . . a convincing example of 'Surface' leadership. Behind the story of these 24 soaking pits at Great Lakes Steel, Detroit Division of National Steel Corporation, is an imposing record of achievement: Surface Combustion has built 80% of all new pits since World War II.

At Great Lakes, six batteries, four 'Surface' pits in each, heat low carbon steel ingots for automotive and appliance steel. They also heat some low alloy steel ("NAX" grade).

Repeat order! Great Lakes just ordered 4 more batteries - now 40 pits in this installation.

These one-way-fired pits include such 'Surface' features as the efficient jet pump recuperative system, and integrated temperature and combustion controls which are of the most modern design. The performance of these pits, and many others, is among the reasons why steelmakers depend on 'Surface.'

SURFACE COMBUSTION CORPORATION, TOLEDO, OHIO

Surface
STEEL MILL FURNACES

Foreign affiliate companies:

British Furnaces, Ltd., Chesterfield; Stein & Atkinson, Ltd., London

Stein & Roubaix, Paris, Liege, and Genoa; Chugai Ro Kogyo Kaisha, Ltd., Osaka

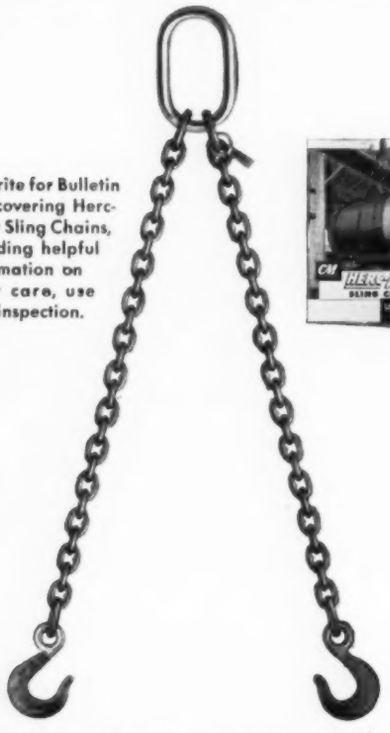
Benno Schilde Maschinenbau, A.G., Bad Hersfeld (Hessen, Germany)

HERC-ALLOY

SLING CHAINS

● Herc-Alloy is the only exact-size alloy chain on the market. This uniformity gives you a lighter and easier-to-handle chain without any sacrifice in working load limit.

● Herc-Alloy, the original alloy steel chain, is available in running lengths as well as in all types and sizes of slings made to customer specifications.



● Write for Bulletin 100 covering Herc-Alloy Sling Chains, including helpful information on their care, use and inspection.

● CM also produces a complete line of chain attachments and welded chain of all types including stainless steel and bronze.

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HOISTS AND CHAIN

COLUMBUS McKINNON
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Herc-Alloy®

(Continued from page 170)

mist separation section prevents carryover of liquid wash oil in the gas.

The light oil recovered by Crucible is sold in three commercial grades: nitration grade benzene, for which the detergent market is the biggest tonnage user; nitration grade toluene, used principally in explosives and solvents; and mixed xylenes, for solvent use.

CONTINENTAL TO BUILD ADDITIONS AT WHEELING

▲ Additions to present buildings in the Wheeling, W. Va., Works, of Continental Foundry & Machine Co. are under construction to provide better working conditions in the machine shop and erection floor areas.

Overall the machine shop will measure 68,594 sq ft; the erection floor will be enlarged to a total of 24,540 sq ft.

A full range of machine tools at Wheeling makes it possible for Continental to machine upwards to the largest castings required by industry. For example, the machining of large housings for all types of steel or nonferrous rolling mills. The enlarged erection floor will allow for more efficient shop erection of the large heavy machinery before shipment.

BEGINS WORK ON NEW PREHEATING FURNACES

▲ Newport Steel Corp. has started construction of two ingot preheating furnaces as part of the mill's program for a further increase in production capacity.

The additional facilities are being installed in the Wilder, Ky., plant section housing the new reversing hot strip mill, and will complement the six circular soaking pits which now service the hot rolling operation.

Newport Steel's production capacity was stepped up last month with the return to operation of two more of its seven open hearth furnaces. A total of three electric and five open hearth furnaces are now in service.

ANNOUNCES PURCHASE OF WARREN STEEL UNIT

▲ Armco Steel Corp, has completed the purchase of the Middletown, Ohio facilities of Warren Steel Corp.

The plant and office buildings have approximately 40,000 sq ft of working space, and will be used to house Armco's expanding fabricating and warehousing operations.

Always the RIGHT ANSWER...

To The Need For Increased Production at Lower Cost

MISSOURI-QUALITY

REFRACTORIES

WANT THE ANSWER TO:

Each time-tested Walsh Refractory product for the steel industry is an investment in greater production... lower cost ... the result of better research and ceramic engineering.

Toughness... high heat transfer ... • **APEX, Extra Duty Fire Brick** ... for checker brick work; in hot blast stoves and open hearths and for lining torpedo type closed ladles.

Resistance to prolonged hot metal loads ... • **MULLITEX HB (high burn) Super Duty Fire Brick...** for hot metal mixers.

Close size tolerances ... • **WARCO XX High Duty, First Quality Fire Brick...** in standard and special shapes, for checker chambers and checker brick work.

Higher refractoriness ... • **WR LADLE BRICK** ... characterized by permanent volume high P. C. E.... for minimum non-metallic inclusions in molten metal.

Strongest brick joints at all ... temperatures • **MORT-AIRSET, High Temperature Airsetting Cement...** Highest moisture retention for fastest application to produce extra strength... air tight joints.

Reduced heat flow ... • **LITE WATE CASTABLE REFRACTORIES** ... for insulating crowns of checker chambers and fantail areas.

Lessened metal penetration ... • **METALOK, Slag Resistant Mortar** ... for ladle brick linings.

Write for complete details

WALSH REFRACTORIES CORPORATION — America's Best Clays

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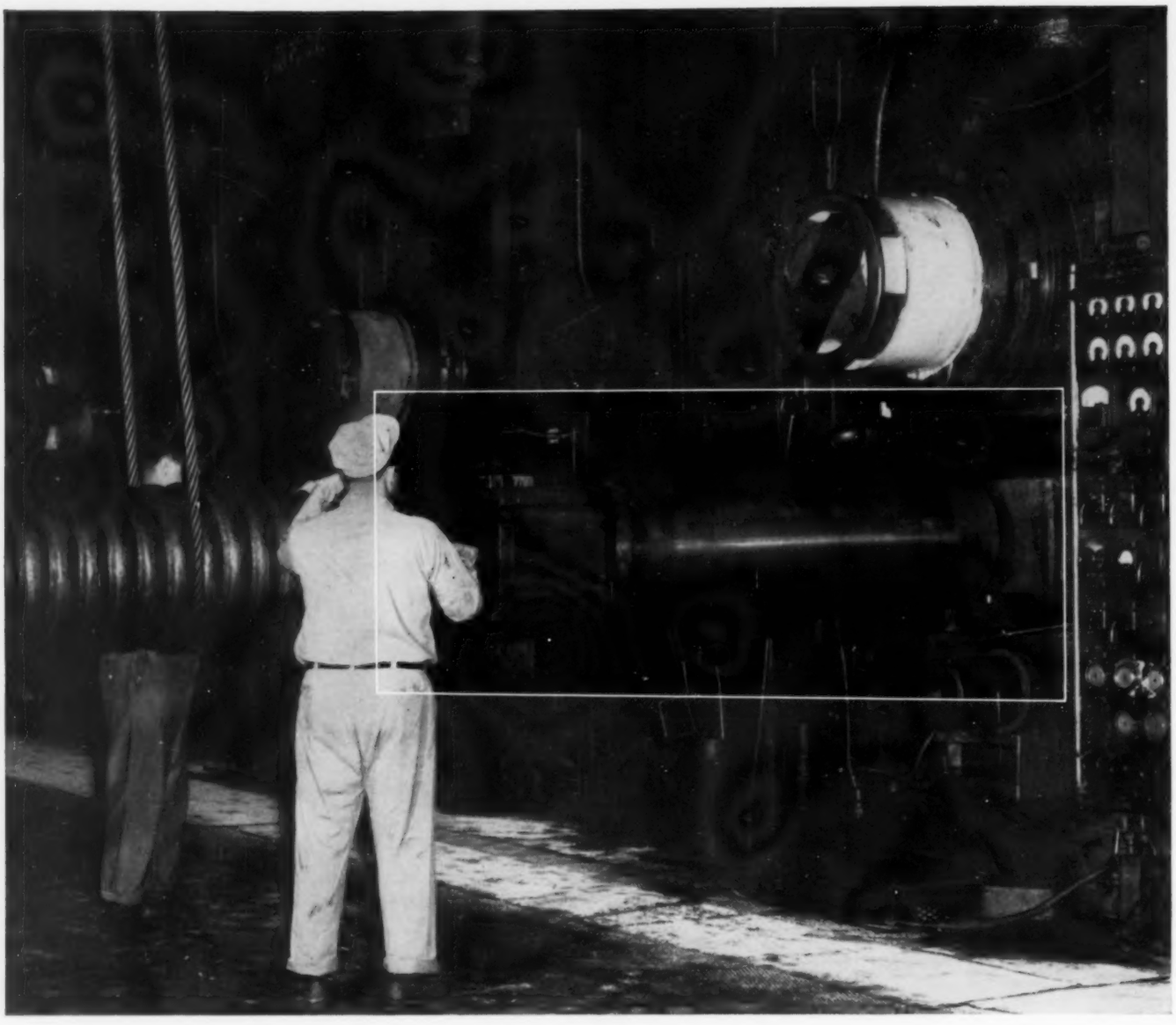
FOR OVER 60 YEARS MANUFACTURERS OF HIGH GRADE REFRACTORIES



From This One Roll, 87,000 Miles of Sheet

The forged roll in this picture is on its way to an honorable retirement. All its life it has worked diligently in that 66-in. cold reduction mill. It's a Bethlehem roll, and when it was first put in service, a performance check was instituted. This, of course, was intended to provide a measure of its durability.

When finally taken out of action, the roll had accounted for 87,000 miles of finished sheets. That's enough sheets to go around the earth nearly 3½ times.

This would seem to be pretty good evidence that the roll was well made. In quality it was typical of Bethlehem rolls, which are manufactured by a corps of true experts right down the line.

You can order Bethlehem forged-steel rolls in any size, any type, and be sure of getting what you want. Specifications on hardness, dimensions, and finish can always be met in full. And rest assured, every phase of the order is checked 100 per cent before the job leaves our shops.

When you are next in the market for rolls, large or small, we invite you to check with our engineers. They'll welcome the opportunity to talk things over with you.

Bethlehem Forged-Steel Rolls are recommended for:

- Cold-rolling ferrous sheets and strip
- Running-down and finishing operations on copper and brass sheets
- Hot- and cold-rolling of aluminum sheets
- Cold-rolling of aluminum foil

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

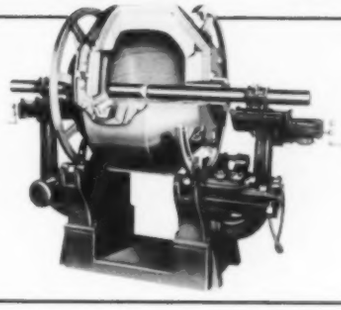
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

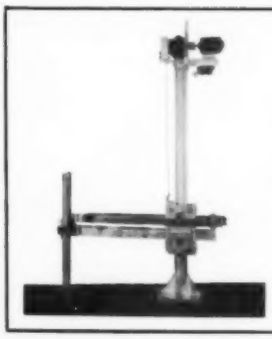
NATIONAL CARBON COMPANY'S

CARBON AND GRAPHITE NEWS



THE INDIRECT ARC ELECTRIC FURNACE—our feature article looks at this seasoned campaigner in the drive for better, more economical melting practice.

GUEST AUTHOR, Bruce W. Schafer, knows his indirect arc furnaces — he manages the company that makes them. Here's a valuable addition to the literature on this subject, prepared especially for Carbon and Graphite News.



ELECTRIC ARC HOT TOPPING offers drastic reduction of crop loss in foundry and mill. Experimental data are cited, with some actual applications and an estimate of the method's promise of new economies in common-steel ingot production.

CARBON AND GRAPHITE NEWS

JUNE-JULY, 1955—Vol. 2, No. 2.

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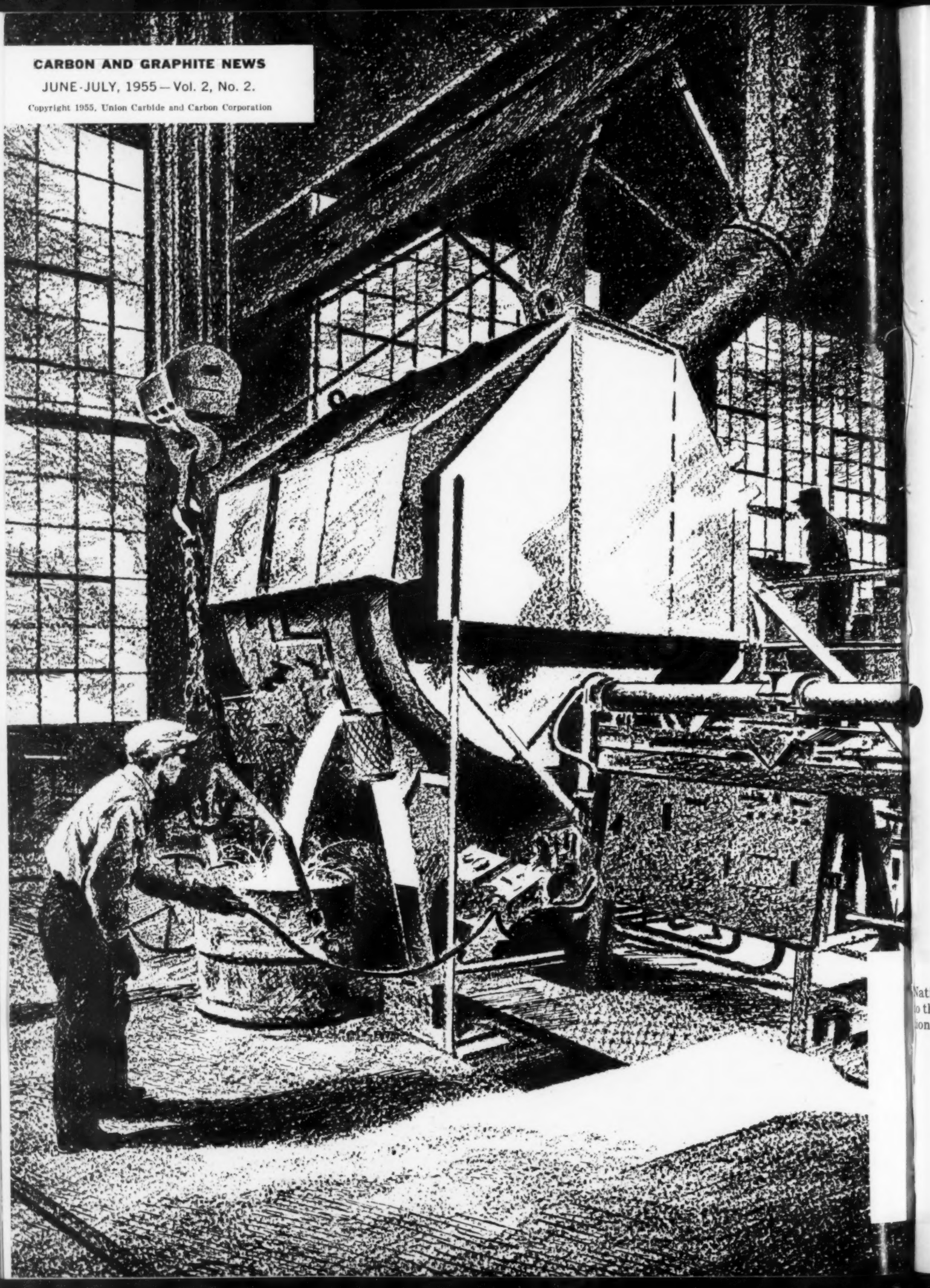


THE INDIRECT ARC ELECTRIC FURNACE DEVELOPMENT AND APPLICATION

By B.W. Schafer

THE INDIRECT arc electric furnace is as large a potential factor in the 5,000 foundries in America as the direct arc type is proving to be in the steel mills. Although the indirect arc furnace was developed primarily for non-ferrous metal melting, it has found a broad field of application in the melting of iron and steel. The types of metal melted in the indirect arc furnace are constantly becoming more numerous to keep pace with the growing needs of industry; as new alloys are produced, different melting techniques are likewise developed.

Indirect arc furnace capacity is now divided almost equally between ferrous and non-ferrous work. This capacity includes not only static sand castings but also permanent-mold and centrifugal castings. Installations for melting gray iron, white iron for heat and wear resistance, ductile nodular iron, special non-ferrous alloys, and stainless and special alloy steels are being made at an increasing rate.

The estimated 65,000-kw. connected load of indirect arc furnaces in the U.S.A. is divided roughly as follows: plumbing goods, 37.8%; bearings and billets, 31.4%; automotive iron, 13.8%; nickel anodes, 7.1%; education and research, 4.2% and miscellaneous, 5.7%.

The increasing use of the furnace is due chiefly to its broad versatility which offers the foundryman an ideal tool for producing castings of high strength and density, having homogeneous structure and closely controlled quality — all with the greatest possible economy.

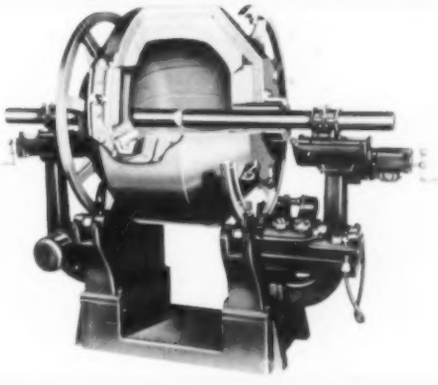
EARLY USES

The indirect arc electric furnace first came into commercial use in 1918, during World War I. Its success in the rapid and economical melting of brass and bronze to meet exacting specifications resulted in the installation of hundreds of such furnaces throughout the world.

From the beginning, the indirect arc has been instrumental in advancing the development of cast iron melting practices; the development of alloy irons, in the 1920's, led to the application of the furnace in this "specialty" field. Since accuracy of results and conservation of alloying elements were prime characteristics of indirect arc melting, the furnace gained immediate acceptance, notably by automotive casting producers.

Having been successfully applied to the alloy iron melting field, it was evident that the melting of many other types of metals would be practical. Among the first specialty metals explored were tool steels and hard surfacing materials such as chromium, nickel and cadmium. Many successful foundry operations today depend primarily upon the indirect arc furnace.

NATURE OF INDIRECT ARC OPERATION



The Indirect Arc Furnace.

The indirect arc furnace differs from other arc furnaces in two fundamental characteristics. First, the electrodes remain clear of the molten bath at all times, the heat being transferred to the charge by radiation from the arc between the electrodes. Carbon pickup from direct contact with the electrodes is thereby eliminated. Second, the furnace can be rotated about the horizontal axis of the electrodes. The melting chamber is rocked through an ever-increasing angle until 90 per cent of the refractory surface is covered by molten metal. This action constantly stirs the bath, insuring the complete homogeneity of the metal; the molten metal absorbs heat previously radiated to the refractory lining above the arc, thus greatly increasing the efficiency of heat utilization while, at the same time, decreasing the temperature of the lining and thereby increasing its life.

(Continued on next page)

ACKNOWLEDGEMENTS

National Carbon Company wishes to express its gratitude to the following organizations for their generous contributions of time and information to the contents of this issue:

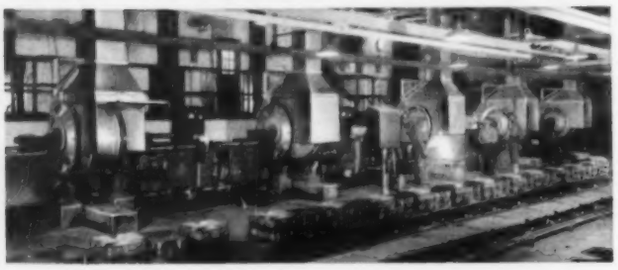
Detroit Electric Furnace Div., Kuhlman Electric Co.
Swindell-Dressler Corp.
Union Steel Castings Div. of Blaw-Knox Co.
Continental Foundry & Machine Co.
S. S. White Dental Manufacturing Co.
Neptune Meter Co. • Jenkins Bros. • Crane Co.

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, New York
In Canada: Union Carbide Canada Limited, Toronto

PRINCIPAL ADVANTAGES

- Close control of temperatures, analyses and production.
- Reduction in metal losses, due to ability to control atm... conditions surrounding the metal during melting.
- Rapid melting, resulting in increased production and les... vola... zation, oxidation and gas absorption.
- Freedom from sulphur, oxides and gas contamination.
- The agitation of the rocking motion assures homogene... y of ... metal during the melting period.
- Elimination of fuel storage and handling.
- Long refractory life.
- Elimination of fire and explosion hazards.
- Improved working conditions in regard to health, cl... nlin...

NON-FERROUS MELTING



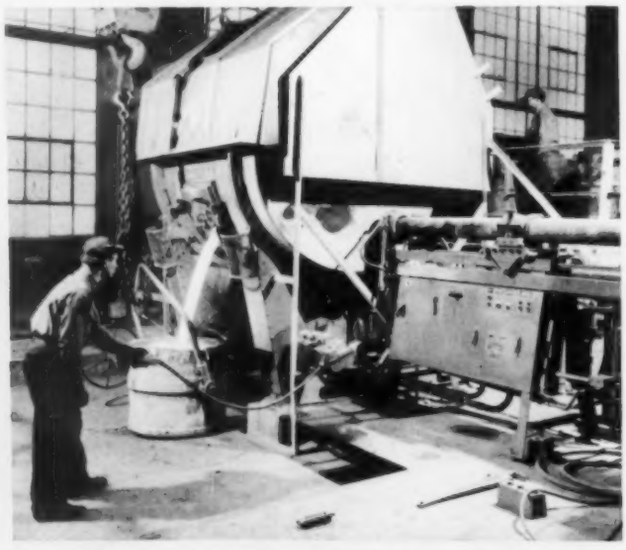
A battery of 700-pound furnaces melting leaded tin bronze for air brake castings.

The first commercial units used in this country were of sufficient size to make brass billet production economical. The furnaces were of 1 and 2-ton capacity. When applied to general foundry use, smaller sizes were needed to insure a steadier flow of hot metal to the pouring floor and to keep each furnace on continuous melting. Today, the most popular sizes for bronze foundry use range from 350 to 700-lb. capacity. For volume operation, batteries of these furnaces are employed to give added flexibility of capacity while retaining efficiency.

Melt time ranges from 6 to 60 minutes, depending upon the furnace capacity, consuming a maximum of 275 kw-hr. of power per ton of 75 per cent copper alloys and about 300 kw-hr. per ton of 85 per cent copper alloys.

The following table is a typical work-cost analysis of the indirect arc furnace melting of 2,000 tons of "82" metal (red brass) per year:

Power: 300 kw-hr., at $0.02	$6.00 per ton
Labor: 2 men, 8 hr/day	4.00 " "
Refractories: 2000 heats per lining, including patch	.75 " "
Electrodes: 4½ lb./ton, at $0.28/lb.	1.26 " "
Maintenance:	.55 " "
Melt loss: ½ per cent at $0.28	2.80 " "
Total cost	$15.36



Reclamation of manganese bronze borings, turnings and crops. Furnace capacity is 12,000 pounds.

This foundry calculated that it would receive a full return on its indirect arc furnace investment in one year, based on the savings from reduced melt-loss alone.

Great emphasis is being placed on the reclamation and recovery of non-ferrous metals. Many companies are using the indirect arc furnace for in-plant recovery of metals formerly recovered by some other method at a high cost or discarded because reclamation was not economical. Spillings, drosses, turnings and the like are efficiently recovered in rocking indirect arc furnaces on a tonnage basis, either by making up part of the melt charge with these materials, or devoting the full capacity of the furnace to a reclaiming charge. Recovered metals usually are cast as billets or ingots which can be worked back into the foundry operation. Billets so produced are in the form of wire bar, rolling mill stock or some other easily handled form.

FERROUS MELTING

Melting iron and steel alloys for automotive castings.

Use of the indirect arc furnace for melting steel is confined almost solely to the stainless, high-alloy and high-carbon types.

Under the indirect arc principle, melting and super-heating are carried out without a slag covering, which permits all of the alloying elements to go immediately into the bath for maximum alloy utilization. Since many alloying elements are quite expensive, this practice produces a substantial saving. There also is less likelihood of slag, gas and oxide inclusions in the product. Any percentage of fine scrap can be melted without appreciably increasing the percentage of metal loss by oxidation.

E INDIRECT ARC FURNACE

fume , excessive heat and possibility of accidents.

T e following may be cited as applying particularly to the melting of iron and steel:

No s ag is used so that the molten material has practically the same chemical composition as the material charged.

The f ct that no slags are necessary permits reasonable control of the c nalysis without expert metallurgical operating knowledge.

The r cking action of the furnace provides automatic washing of the refractory lining, with the result that the walls are but little hotte than the metal. This promotes greater refractory life, as well as elimination of local overheating and more efficient utilization of the arc heat.

The desired amount of superheating may be obtained.

Straight carbon steel melts are made regularly in the indirect arc furnace by charging good, clean steel scrap of the same composition as ultimately desired. When such melts are made, additional deoxidation should be provided by adding aluminum or other available deoxidizing agents to the charge. By proper care in the selection of the charge and in melting, no detrimental effect on the life of the lining should result.

Reducing, oxidizing or neutral melting atmospheres can be provided, as desired, thereby affording a valuable control of chemical reactions in the molten bath and allowing much broader latitude in controlling the time devoted to superheating.

The economies available in ferrous practice are evident in the fact that only from 12 to 90 minutes are necessary per melt, the time depending upon the capacity of the furnace and the type of charge. Average current consumption per ton of either gray iron or malleable is 600 kw-hr.

The indirect arc furnace is used for duplexing by charging metal from the cupola to the furnace for superheating and for the addition of alloying materials such as manganese and chrome; or nickel and chrome may be melted in the electric furnace to make molten alloy additions to the ladle. In either case, a higher recovery of alloys is obtained than in straight cupola melting. The economics of duplexing are very favorable as shown by an average use-figure of 100 kw-hr. per ton for each 300 degrees F. of temperature rise.

Ductile irons, one of the outstanding foundry developments since the introduction of malleable iron, are a relatively new family of cast metals that have been added to the long list of indirect arc furnace products. The ductile irons, to a large degree, bridge the gap which long existed between cast iron and steel. They have the processing advantages of cast iron — good fluidity and castability, ready machinability and low melting point — combined with many of the engineering advantages of steel — good strength, toughness, wear resistance and substantial ductility. Ductile iron can be bent, twisted, drawn and otherwise deformed without fracture, and has several times the strength of ordinary gray iron, in addition to an exceptional resistance to shock. These are highly desirable properties for parts that are too intricate to be cast in steel or for those having inadequate mechanical properties when cast in gray iron. In addition, producing ductile iron in the indirect arc furnace adds a high degree of flexibility with respect to size, intricacy and number of castings that can be produced economically at a given time.

The making of synthetic iron in the indirect arc furnace represents a "reverse process" in which steel scrap is charged and carbon added, to produce high grade iron. Where small amounts of iron are required, the indirect arc furnace is economical by virtue of its ability to use low-priced steel scrap and to permit very close control of the charge.

It is well to emphasize that, as new alloys are produced, different melting techniques are developed, none of which has been troublesome because of the flexibility and versatility of the indirect arc furnace.

INVESTMENT CASTING

Precision-casting of jet-engine components by the "lost-wax" process.

Immediately prior to and during World War II, the Investment Casting or "lost wax" process developed into wide use to solve many critical problems caused by the drastic shortage of machine tools. It was used for casting highly-alloyed steels and very intricate sections that were previously machined from solid stock.

The "lost wax" casting technique was used by the ancients for making jewelry and other articles having complex shapes and design features, and requiring accuracy and fine surface finish. An exact replica of the article to be reproduced was made in wax; the wax form was then coated with a thick layer of fine, clay-like moulding material, after which the wax was melted out to leave a form

(Concluded on last page)

CROP LOSSES REDUCED WITH ELECTRIC ARC HOT TOPPING

EVEN in the days of relatively moderate labor, fuel and equipment costs, considerable interest and experimentation were directed toward improving sound-metal yield in ingots and large castings. Various designs of clay and ceramic hot tops and exothermic fluxes were, and are, among the methods used.

The presence of either of two conditions is alone sufficient to place a high value on effective hot top practice: (1) high *handling* costs encountered in cropping and re-processing scrap from very large ingots and castings; or (2) high *material* cost as represented by the crops of high-alloy product.

First Used on Non-Ferrous Ingots

This latter consideration led to the pioneer development of arc hot top equipment and practice by the International Nickel Company, Inc. at its Huntington Works. Applied exclusively to non-ferrous ingot castings of high nickel content, the method was in commercial use by 1924 and, with some refinements, is still used today.

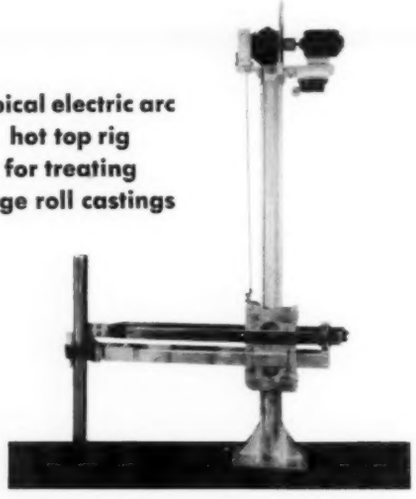
Despite early unfavorable speculation regarding its applicability to ferrous metals with marked segregation characteristics, electric arc hot topping has been used successfully on many types of high-carbon steels and, on the basis of experience to date, promises to deliver substantially the same advantages on ingots and castings of mild-steel and low-alloy content.

Foundry Applications

At the opposite extreme from those of non-ferrous ingot production are steel foundry problems resulting from metal shrinkage in large roll castings. Here tremendous masses are involved. The costly torching and/or lathe-cropping of sink-heads weighing up to ⅔ of the rolls themselves, the low quality of metal remaining in the crops, the necessity for cleaning and splitting massive scrap for re-processing — all combine to place a premium on reduction and control of the riser.

Early arc-top installations in roll foundries required manual adjustment of the electrode column with resulting high labor cost and occasional failure of the arc. Recent installations favor automation, with power adjustments being made at a single remote panel for all units in operation. Virtually the only attendance required is for the purpose of adding such slag as is necessary to maintain a stable arc. Because masses are large and the sand molds have an insulating effect, solidification is slower, and longer application of the hot top is necessary than in mill practice. Cycles range from seven to 24 hours, depending upon a function of the column and length/diameter ratio of the roll.

At least one such installation was originally equipped with holders for 3″ graphite electrodes, but was later converted to 4″ diameter to obtain a burning time of approximately nine hours. This installation uses a single electrode, but others, employing two and three-electrode rigs, also favor

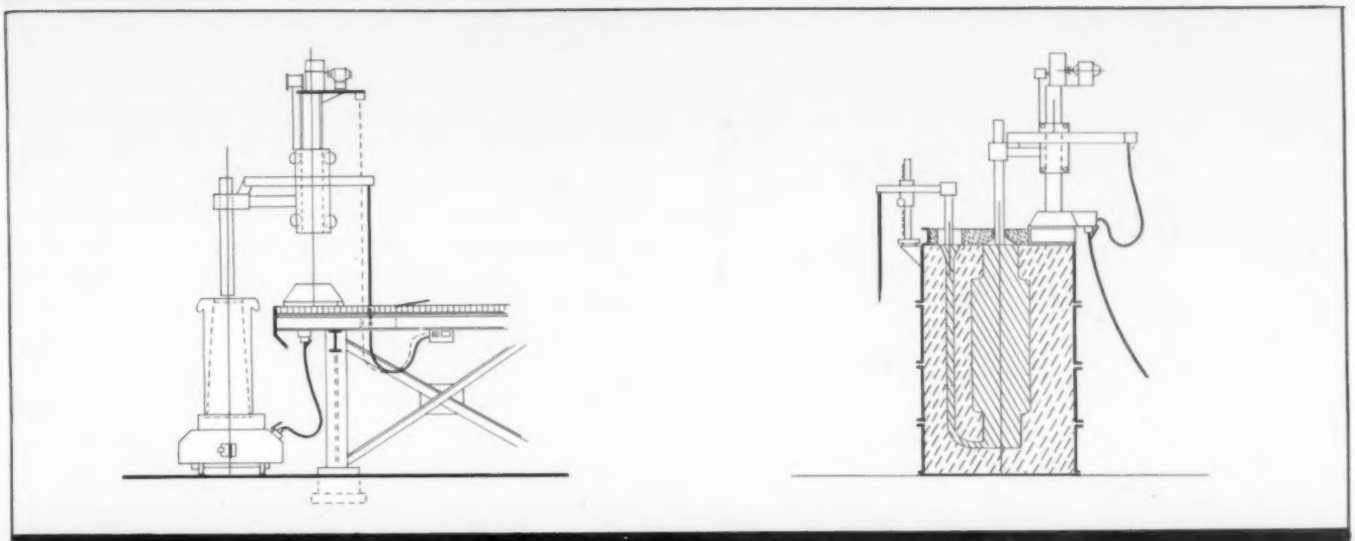


Typical electric arc hot top rig for treating large roll castings

the 4″ x 40″ size for optimum burning time and consumption per ton of metal.

One foundry reports a 50% reduction in sink-head weight by electric arc hot topping which — besides the obvious savings in fuel, handling and materials — enables them to pour castings in a single heat which formerly required a second heat to fill the head. Prior to arc hot topping, this foundry sometimes found it necessary to torch off a portion of the head in order to get a roll into the annealing furnace. Since experience had shown that rolls must be lathe-cropped in any event, prior to turning, this last situation was especially undesirable and has not occurred since arc hot tops were installed in 1950.

Roll metal is in the high-carbon range — .50 to .250 points — and may contain, in addition, nickel, chromium, molybdenum and tungsten in varying proportions. Since rolls are bottom-poured through a tangentially-located sprue, the swirling action of



Schematic arrangement of equipment suitable for hot topping both castings and ingots. Two and three-electrode power units are also used.

the entering metal tends to force any segregates toward the longitudinal centerline of the casting where they are well within specification tolerances. It is interesting to note that, while results of early experiments on ingots revealed a *negative* carbon segregation in the arc hot top, one foundry refers to carbon "pick-up" when arc-treating low-carbon steel. However, this same company has hot topped low-carbon anvil castings up to 268,000 pounds in a single piece with excellent results.

Some Notes From Abroad

Reports on European practice indicate a much wider commercial application of arc hot topping in steel mills there than in this country. Experience ranges from 200,000-pound forging ingots to 200-pound tool steel ingots. A French report states that piping is completely eliminated and segregation measurably improved in arc-topped ingots. Slag practice, which may materially influence the latter condition, is not described. Austrian practice appears to be highly successful in ingot production, subject to a strict set of conditions — among them the observance of a 1:2 ratio of ingot diameter to length. Other countries reporting favorable results in both mill and factory arc-treating include England, Germany and Belgium.

Prospects For Ferrous Ingot Production

What is the outlook for electric hot tops in U. S. mills? Every increase in the cost of labor, fuels and raw materials brings additional economic pressures toward higher ingot yield and improved quality of metal. As the demand increases for high-strength and other special-properties steels, the greater unit-value of product further aggravates the expanse of crop-handling and re-processing. The last 50 years have seen substantial reduction of crop-loss. Is arc hot topping the next big step forward in tonnage-steel production economy?

Some time ago, National Carbon Company, A Division of Union Carbide and Carbon Corporation, conducted experiments to determine the best electrode size, power characteristics and treating time necessary to reduce or eliminate top shrinkage due to piping in ingot castings. Experimental ingots were 8-inch square; electrodes, ¾" and 1" diameter; slags included lime-silica-magnesia and preformed silica lime. Electrode consumption on this small-scale operation was about 8 ounces per ton of ingot, with power averaging 14 kw-hr. per ton — both low figures by comparison with European practice. Low-carbon, low-alloy steel ingots, rolled without cropping, did not split. Stainless ingots were fully workable with less than 5% crop-loss.

Such encouraging results prompted production-scale tests, which were carried out in the mill of a large Eastern producer. Here, ingots were arc-treated and compared with standard ingots. The comparison ingots showed blow-holes extending more than a foot below their standard clay hot tops. Ingot surface in the treated molds was perfectly flat. Some negative segregation of carbon, manganese and silicon was discovered in the upper third of the electrically-heated ingots due, it is believed, to the use of siliceous slags in treatment. There is every reason to believe that such losses can be corrected by proper slag adjustment.

With a history of more than 30 years in the field of specialty-metals ingot production and with numerous foundry applications, electric arc hot topping is a highly developed practice, offering possibilities of greatly increased efficiency in the growing steel industry.

Previous issues of CARBON AND GRAPHITE NEWS are still available.

Write National Carbon Company, Dept. E, 30 East 42nd Street, New York 17, New York, giving name, title and company address.

The terms "Acheson" and "National" are registered trade-marks of Union Carbide and Carbon Corporation

THE INDIRECT ARC ELECTRIC FURNACE DEVELOPMENT AND APPLICATION

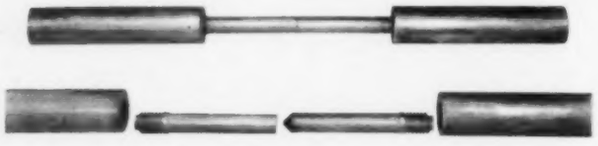
(Concluded)

into which precious, semi-precious or base metal was cast. After the metal solidified, the mold was broken apart to release the finished casting.

Much the same technique is being used today to meet the rapidly growing demand for precision castings. Indirect arc furnaces are admirably suited to this kind of work. For investment casting, a special furnace design has been developed which works as follows:

An air-cylinder clamp attachment holds the mold firmly to the melting chamber which then is inverted to transfer the molten charge to the mold. At this point, air pressure can be applied if necessary to completely fill the mold cavities. A larger, standard furnace may be used to produce the exact analysis required which is cast into rod or shot and charged cold into the special furnace for remelting and casting.

RESISTOR FURNACES



Resistors and terminals for the resistance-type furnace are shown (above) in operating position and (below) disassembled.

Early in the development history of the indirect arc electric furnace it became apparent that many highly volatile as well as low melting-point alloys would be overheated by the 6,000-degree heat of the arc. A lower temperature was possible by using resistor heat in the indirect arc type of furnace. Graphite is the only resistor material available that will withstand thermal shock and high temperature and give a non-oxidizing atmosphere. Essentially, the resistor gives a lower temperature, radiant heat over the entire length of the metal bath. While its efficiency is lower than the indirect arc furnace, steady, easily controlled heat combines with noiseless operation to make the resistor furnace a desirable melting unit for certain applications, such as on ship board. Since it is practically a closed-atmosphere furnace, the metal does not volatilize or oxidize, a fact that makes it most suitable for yellow brass and for melting zinc. Although the temperature range is very broad, the resistor furnace is most efficient at relatively low temperatures.

Resistor rods can be either one or two-piece, secured in graphite terminals extending outside the furnace wall for connection to the power source. The two-piece resistor is used when it is desirable to clear the melt chamber for charging. The conversion of an indirect arc furnace to the resistor type requires a larger capacity transformer because of the radically different power demand characteristics.

CONCLUSION

The indirect arc furnace is being used for a wide variety of metals, divided roughly into three main categories: bronze, iron and specialties.

Bronzes	*Irons*	*Specialties*
60-30 brass	Short cycle malleable	Copper
81-82 plumbing goods	Plain gray iron	Nickel
Navy M, G, Ounce	Ni-Cr-Mo iron	"Monel"
Aluminum bronze	Ductile iron	Stainless steel
Manganese bronze	Nodular iron	Ni steels
Silicon bronze		Beryllium copper

New controls, electrical circuits and mechanical devices have increased the versatility of the indirect arc furnace to the point of making it an almost universal foundry unit. There is no doubt that, as demands are made for new materials, for more specialized products and more economical ways to produce them, the indirect arc furnace will continue to display its flexibility and economy of operation.

B. W. SCHAFER *claims the State of Michigan and, particularly, the Tri-Cities Area as the center of both his home and professional life. Born in Michigan, he received his B.S. in Chemical Engineering from Michigan State College. Following four years' experience at Dow Chemical Company's Electrothermal Division, working on the thermal reduction of magnesium ores, Mr. Schafer joined Detroit Electric Furnace Division, Kuhlman Electric Company, Bay City, Michigan. Now Manager of that Division, he brings to his appraisal of modern melting practices a broad knowledge of foundry problems and objectives.*

***ACHESON* Plant, Niagara Works of National Carbon Company, a Division of Union Carbide and Carbon Corporation.**

Fourth in a series featuring the five National Carbon Company plants devoted to manufacturing carbon and graphite electrodes, *Acheson* Plant, shown here, is one of three integrated locations which together make up the Company's Niagara Falls Works. *Acheson* Plant facilities account for the graphitizing and machining of all "National" graphite electrodes produced in the area. Sister Plants, *Republic* and *National*, conduct forming, baking and machining operations on "National" electrode products.

LITHO IN U.S.A.

Here's how to eliminate crane downtime due to summer heat

Is your steel mill constantly plagued with that annual problem of increased crane downtime caused by summer heat? With ambient temperatures up to 170 F over soaking pit, open hearth, heat treating and similar areas accentuated by high summer temperatures . . . plus dust, dirt and fumes . . . it's no wonder that crane operators need frequent relief—relief that results in *crane downtime* and *lost production!*

These problems are eliminated with Dravo Crane Cab Conditioners. The crane cab conditioner maintains a summertime temperature in the cab of 80 to 85 F . . . filters out dust, dirt and fumes . . . keeps crane operators alert and efficient . . . permits them to work long periods without relief. Dravo Crane Cab Conditioners will assure regular crane operations during those summer hot spells and help maintain production.

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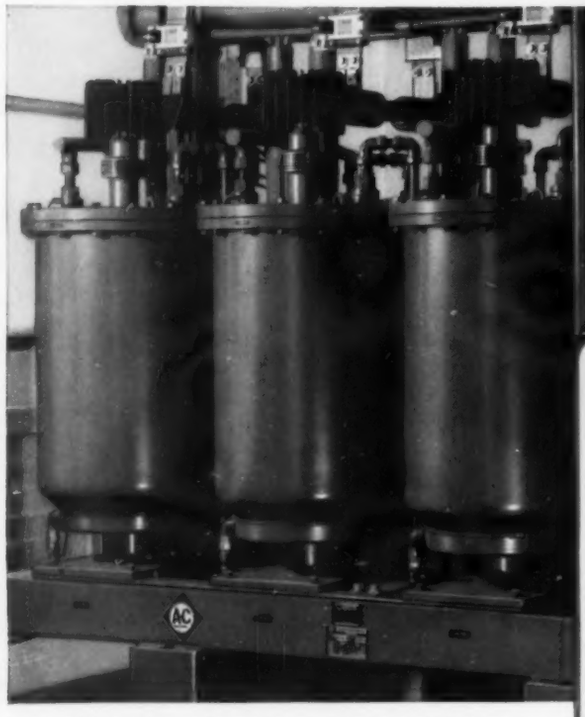
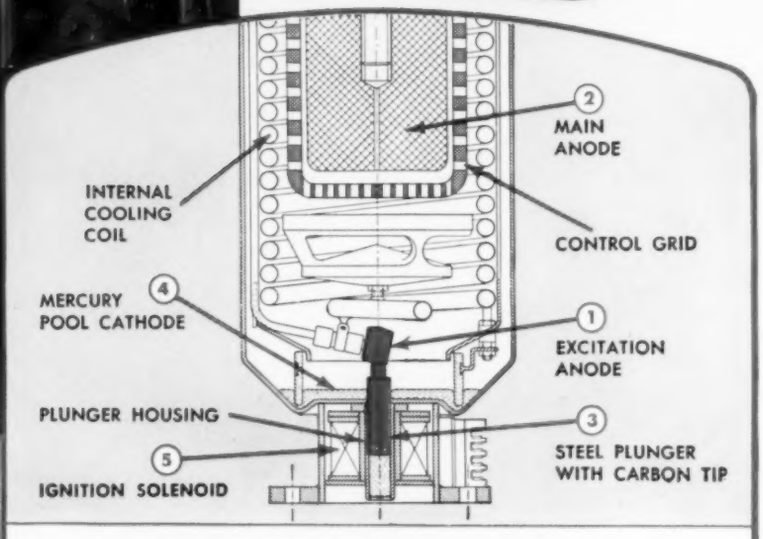
Here's the Rectifier That Needs

No Delicate Adjustments



This 1000-kw, 6-tube excitron rectifier is typical of units used for heavy-duty service in many industrial plants.

ALLIS-CHALMERS
Mercury Arc Rectifiers



Unique Plunger Starts Continuous Excitation

The excitron tube has an excitation anode ① in addition to the main anode ② . With the excitation circuit de-energized, the steel plunger ③ floating in the mercury pool cathode ④ makes positive contact with the excitation anode (as shown).

When the excitation circuit is energized, the ignition solenoid ⑤ pulls the steel plunger ③ away from the excitation anode ① and under the mercury pool cathode ④ , thus drawing a dc arc and forming the cathode spot, which makes conduction of load current by the tube possible.

If power is interrupted the plunger will float up, contact the excitation anode and automatically re-establish the excitation arc when power is restored.

LITTLE MAINTENANCE IS NEEDED with Allis-Chalmers excitron-type rectifiers. Excitation of the excitron rectifier is continuous, while other types of rectifiers require re-ignition 60 times a second.

Since it is more difficult to start a rectifier arc than to maintain it, the excitron rectifier is much less likely to lose excitation during operation. Momentary dips in supply voltage which are encountered in many supply systems have no effect on the continuous excitation arc.

Years of operation in hundreds of installations have proved the reliability and ease of operation of Allis-Chalmers mercury arc rectifiers. You can get complete information from your nearby A-C office. Or write Allis-Chalmers, Milwaukee 1, Wis.

A-4581

ALLIS-CHALMERS

Personnel News...

Harold R. Nelson has been appointed chief research engineer in the research and technology division of United States Steel Corp. In this newly-created position, Mr. Nelson will supervise and coordinate research work in the application of automatic controls, instrumentation, and mechanization to steel processes. Mr. Nelson joined the General Electric Co. at Schenectady, N. Y. in 1941, and spent several years with the United Engineering and Foundry Co. before joining the Columbia-Geneva Steel Division of U. S. Steel in 1951. He was general supervisor of electrical engineering at Geneva Works at the time of his present appointment.

J. Russell Powell has been appointed works manager at the Cleveland Works of Jones & Laughlin Steel Corp. **William P. Smith** was named assistant works manager. Mr. Powell succeeds **Howard H. Shakely** who has been assigned to the general office in Pittsburgh as consultant of the chief engineer. Mr. Smith succeeds **S. C. Faddis** who has been assigned to the Detroit area as contact metallurgist. Mr. Powell has been assistant works manager—sheet and strip at J&L's Pittsburgh Works since June, 1954. Before that he had been assistant works manager—general services at the Aliquippa Works since 1951. He joined J&L in 1923 as a wireman in the electrical department at Aliquippa. After a succession of supervisory jobs, Mr. Powell was made superintendent of tin mill products at Aliquippa in 1948. Mr. Smith joined J&L in April 1952, as general foreman—electrical in the tin mill at the Aliquippa Works. In August 1953, he was made general foreman—maintenance in the tin mill; in February, 1955, he became general foreman—maintenance of the South Mills at Aliquippa.

Carl G. Hogberg has been appointed assistant to vice president of Michigan Limestone Division, United States Steel Corp. Mr. Hogberg began work as a blast furnace apprentice at United States Steel's South Chicago Works in 1935. In 1941 he was transferred to Pittsburgh and since that time has been associated with blast furnace activities on U. S. Steel's operating committees, in Pittsburgh.

Harold B. Emerick has been named director of Technical Services Division of Jones & Laughlin Steel Corp. He succeeds **D. T. Rogers** who was named manager—cold finished products. Mr. Emerick joined J&L in 1935 as a metallurgical inspector at the Aliquippa Works. He became assistant chief metallurgist in 1947 and in 1951 became assistant to the vice president of technology. He was appointed assistant director of technical services in 1953.

Benjamin F. Fairless, whose retirement as chairman of the board and chief executive officer of United States Steel Corp. was announced last month, was named president of the American Iron and Steel Institute. Serving without salary, Mr. Fairless will act as general spokesman for the industry, a role he often filled before his retirement from U. S. Steel.

James J. Munns has been elected a senior vice president of National Steel Corp. He has been identified with National Steel since 1935, serving in research and related capacities with various subsidiaries of the company. Prior to his present appointment he was vice president in charge of the over-all direction of research and control of quality throughout the National Steel organization and will continue to direct these activities.

Harleston R. Wood has been elected president and chief executive officer of Alan Wood Steel Co., to take office August 1. Mr. Wood will succeed **John T. Whiting,** president since 1939, who will continue as chairman of the board of directors, a post he has held since 1941. Mr. Wood has been vice president in charge of planning and development.

John B. Mitchell formerly executive vice president—production, Jones & Laughlin Steel Corp. ended his two-year role as consultant to the president of the corporation on June 1. Mr. Mitchell started with J&L in 1915 in the Aliquippa Works machine shop. Among the numerous posts held by Mr. Mitchell during his 40 years at J&L were: superintendent of 14-in. bar mill; management's special representative in charge of industrial relations; in charge of all bar rolling mills at Pittsburgh Works; assistant to the vice president of manufacturing operations; and general manager of manufacturing operations.

Robert R. Estill, a retired employee of U. S. Steel Corp., was elected president of Green River Steel Corp. **Sidney D. Williams,** the outgoing president, will be-

HAROLD R. NELSON

J. RUSSELL POWELL

CARL G. HOGBERG

HAROLD B. EMERICK

come vice chairman of the board. **William C. Fisher** will remain as chairman. Mr. Estill joined U. S. Steel in 1938 as superintendent of its Lynch, Ky. coal mines and more recently had been manager of the company's fluorspar properties in Crittendent County, Ky. In 1947, he was loaned by U. S. Steel to serve as American chairman of the U. S. and United Kingdom coal control board in Germany.

W. Roy Willard has been named assistant to the president of Buffalo Steel Corp. Mr. Willard comes to Buffalo Steel after 18 years with Republic Steel Corp.

W. ROY WILLARD

in Cleveland, Ohio, where he was employed in the operating, metallurgical and sales departments.

Cyrus N. Johns, president, American Chain & Cable Co., Inc., has been elected the company's chief executive officer. He succeeds **Wilmot F. Wheeler,** who has held this position since 1946. Mr. Wheeler will continue as chairman of the board. Mr. Johns joined Page Steel &

CYRUS N. JOHNS

Wire Co., later acquired by American Chain & Cable at Monessen, Pa. in 1916. He was appointed works manager of the Page Steel & Wire Division there in 1930, and later served as general manager of that division. In 1940, he was appointed vice president in charge of operations for all ACCO plants. He became executive vice president in 1946 and president in 1951.

John L. Young was recently honored as the "Engineer of the Year" by the Beaver Valley Chapter, Pennsylvania Society of Professional Engineers. Presentation was made by Michael Baker, Jr., the 1953 award winner. Mr. Young is vice president in charge of engineering of United States Steel Corp. and a past president of the Association of Iron and Steel Engineers.

S. S. Burns, former chief engineer of Marathon Electric Manufacturing Corp. in Wausau, Wisc., has just been promoted to the position of director of research and development for the same company.

Clarence J. Pistor has been appointed manager of the Lancaster, Pa., warehouse of the Jones & Laughlin Steel Warehouse Division of Jones & Laughlin Steel Corp. Mr. Pistor succeeds **Jack K. Kreutzer.** Mr. Kreutzer has been assigned to the staff at the division headquarters in Indianapolis, Ind.

Dick W. Pehl was appointed to the position of assistant superintendent of mechanical shops at the Fontana, Calif., plant of Kaiser Steel Corp. He was

DICK W. PEHL

formerly general foreman and has been with the company since 1949 when he started as a production assistant.

Edward W. R. Butcher, has retired as chief mining engineer of Republic Steel Corp.'s northern ore mines, a post he has held for 37 years. Mr. Butcher joined the Republic Iron and Steel Co. in 1909 as assistant chief engineer in the company's Minnesota mines. He was employed as mining engineer and safety inspector at the Cambria and Antoine Ore Co. in Mich. in 1917 and was named chief mining engineer of Republic's northern ore mines in 1918. Until 1942 he was also in charge of industrial relations for the district.

George F. Groff has been named to the position of vice president of finance of Crucible Steel Co. of America. Mr. Groff has been controller for the company since 1953. Also, **Daniel A. Porco** has been named controller. Mr. Porco was formerly an assistant controller for Crucible.

H. D. McLeese has been appointed general sales manager of Metal & Thermit Corp. Mr. McLeese,

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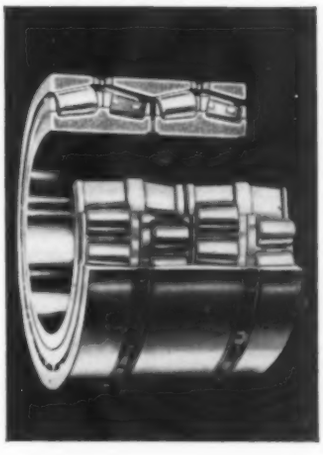

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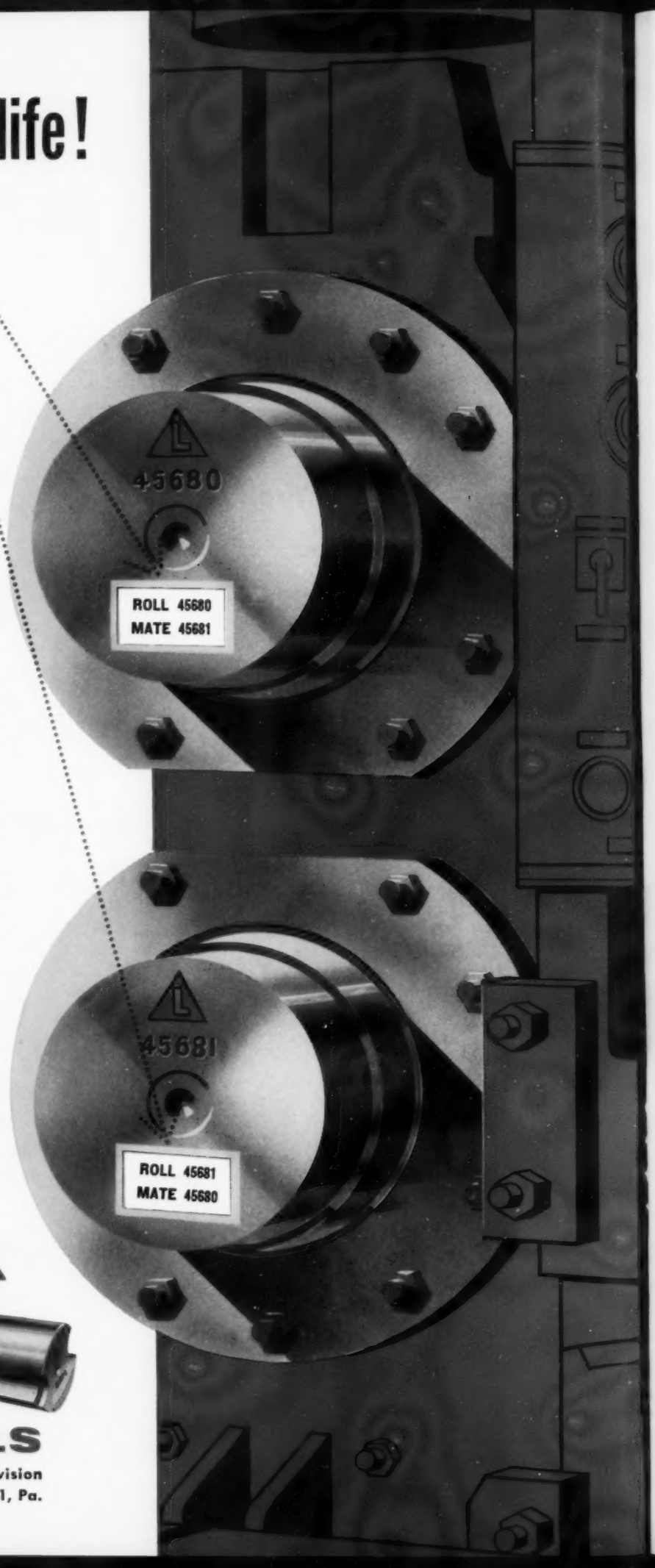

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previously vice president and general sales manager of the company's subsidiary, United Chromium Inc., will direct the sales of all Metal & Thermit and United Chromium products.

William S. Tuttle, formerly superintendent of Republic Steel Corp.'s Troy, N. Y., coke plant, has been named assistant superintendent of the Warren coke plant. **George F. Schick** has been appointed assistant superintendent of the hot strip finishing department. Mr. Tuttle was an operating engineer with the Koppers Co. when he joined Republic in 1951 as general foreman of the Troy plant. He was made superintendent in 1954. Mr. Schick joined Republic in Warren in 1934 in the hot strip mill inspection department. At the time of his recent appointment he was a general turn foreman.

Edwin H. Ahlefeld, Jr. was named assistant general sales manager of Farrel-Birmingham Co., Inc.

EDWIN H. AHLEFELD, JR.

Theophil H. Mueller, assistant to the president of the Torrington Co., was elected a director to fill the vacancy caused by the resignation last December of **R. B. Nichols. Milton E. Berglund,** director and vice president of manufacturing, has been elected executive vice president. **Lawrence W. Smith,** assistant to Mr. Berglund, succeeds him as vice president of manufacturing. Other changes are: **Byron T. Virtue** elected vice president of engineering, a new office; **Edward B. Thompson,** bearings division sales manager at Torrington, elected vice president of sales.

Dr. C. Earl Webb, chief engineer for U. S. Steel's American Bridge Division, has retired after serving 41 years in the bridge building business. He began his association with American Bridge in 1914 as a draftsman in the plant at Gary, Ind. In 1922 he became designing engineer at the company's Chicago office and served in this position until 1935 when he was made division engineer in Chicago. In 1946 he came to Pittsburgh, Pa., as chief engineer the position held until his retirement.

Earle D. Moiles, Jr., has been promoted from sales field engineer to district manager of the Boston, Mass. office of Leeds & Northrup Co. He replaces **Paul K. Welch,** who becomes manager at New York.

Vincent P. Rumely, senior vice president and member of the board of directors of Crane Co. has retired. Mr. Rumely became associated with Crane Co. in 1937 as a production engineer. He was named manager of Crane's Chicago Works in 1938. Three years later he was elected vice president of manufacturing. In 1953 he was appointed senior vice president of manufacturing.

John W. Murchie has been appointed an assistant chief industrial engineer for Republic Steel Corp. He succeeds **Samuel C. McDowell,** who recently was appointed division manager of Republic's Pressed Steel Division. **Floyd J. Titler** and **William H. Coghill** continue as assistant chief industrial engineers. Mr. Murchie has been district industrial engineer for Republic's Chicago district plants for the last 14 years. He will make his headquarters at Republic's general offices in Cleveland. He joined Republic in Youngstown in 1933 as a time study man. In 1935 and 1936 he was an industrial engineer at Republic's Warren, Ohio, steel plant. For five years before going to Chicago in 1941 he traveled throughout the Republic organization handling a variety of industrial engineering assignments.

A. A. Markson has been named assistant vice president in charge of engineering for Hagan Corp. Formerly head of mechanical research and development, Mr.

A. A. MARKSON

Markson in his new position will assist **R. R. Donaldson,** company vice president in charge of engineering, in the coordination of all engineering activities in Hagan's mechanical division.

William E. Clark was elected executive vice president of Dravo Corp. Mr. Clark, previously vice president and general manager of the firm's Engineering Works Division, replaces **Alex. W. Dann,** who has just retired after 42 years with Dravo.

William A. Yost, Jr. has been appointed to the newly created post of vice president, staff operations, Allis-Chalmers Manufacturing. Co. Previously, Mr. Yost was vice president, general machinery division, a position he has held since September 1951. In his new position he will generally direct activities in the firm's industrial relations, public relations, legal, purchasing, comptroller and research divisions. Mr. Yost came to

Allis-Chalmers in 1943 as manager of the marine division, steam turbine department after being employed by Elliott Co. In 1945 he was appointed assistant manager of the Allis-Chalmers steam turbine department, and in 1947 he was named manager.

Eugene L. Mackey has been promoted to director of engineering at the Yoder Co. A veteran of 20 years with the company, Mr. Mackey was formerly chief engineer in charge of estimating.

R. B. Fulton was appointed manager of the Cincinnati district of Allis-Chalmers Manufacturing Co. general machinery division. He succeeds **W. F. Daly,** who is retiring June 30 after more than 30 years of service with the company.

Claude B. Kershner has been appointed director of purchases for Birdsboro Steel Foundry & Machine Co.

Eugene H. Kinelski has joined the Development and Research Division of the International Nickel Co., Inc., as a research metallurgist in the welding section of the research laboratory at Bayonne, N. J. The welding section is engaged in study of the welding of all types of alloys and in the development of new welding rods and coated electrodes. Before joining International Nickel, Mr. Kinelski was associated with Inland Steel Co., Pullman-Standard Car Manufacturing Co., and Sintering Machinery Corp.

H. E. Boedecker has been appointed superintendent of construction at Northeastern Steel Corp., Bridgeport, Conn. Mr. Boedecker was formerly with Rotary Electric Steel Co., Detroit, Mich.

H. E. BOEDECKER

Henry S. Schaufus was named chief metallurgical engineer of Vanadium Corp. of America. Mr. Schaufus has been associated with Crucible Steel Co. of America, Eastern Stainless Steel Corp., and Rustless Iron and Steel Corp. More recently, he has acted in a consultant capacity to the steel industry.

Arthur R. Lytle has been appointed vice president in charge of research for Electro Metallurgical Co., Division of Union Carbide and Carbon Corp. He has been associated with the corporation since 1923 when he joined the research laboratories at Niagara Falls, N. Y. In 1946, he became head of the welding department there and was subsequently appointed assistant manager of research. In 1952 he moved to the New York office to occupy the post of director of research for Electro Metallurgical Co.

John R. McPhee was elected vice president in charge of all sales operations of the Ironsides Co. A director of the company, Mr. McPhee had previously been vice president in charge of sales for the Palmoshield division.

Alexander Zeitlin has been elected vice president of the Birdsboro Steel Foundry & Machine Co. In addition Birdsboro acquired Engineering Supervision

ALEXANDER ZEITLIN

Co. of New York, which Mr. Zeitlin will continue to head as president. Mr. Zeitlin has served for the past six years as vice president and general manager of Loewy Construction Co. and vice president of Hydropress, Inc., its parent company.

Frederick S. Thompson was elected chairman of the board of directors and chief executive officer of the Corhart Refractories Co. At the same time **Hugh L. Kline** was named president and general manager, and **John K. Meyer** was appointed vice president. Mr. Thompson has been manager of sales, general manager, vice president and president of Corhart since coming to the company from General Electric in 1928.

Horace Drever, president, Drever Co., **C. E. Hawke,** vice president, the Carborundum Co., and **Walter H. Holcroft,** executive vice president and technical director, Holcroft & Co., were recipients of the 1955 Trinks Industrial Heating Award. The award, bestowed annually by a judges' panel of industrial heating authorities for outstanding contributions to industrial heating, was established in honor of Dr. Willibald Trinks, professor emeritus of Carnegie Institute of Technology, and world authority on industrial heating problems.

Carl Brehl was named superintendent of maintenance at Washington Steel Corp. Mr. Brehl joined Washington Steel in 1947 as maintenance foreman.

Gilbert C. Mott, chief industrial engineer of the Bridgeport Brass Co. has been appointed director of engineering, and in this new post will be a member of

Machine-Cutting Clears the Way to $13,000 Savings

One steel company is saving up to $13,000 a year by using oxygen shape-cutting machines for making ingot and pan links from steel plate.

Previously these parts were forged at an annual cost of approximately $30,000. The speed and accuracy of oxygen shape-cutting cut costs to $17,000 a year—a savings of more than two dollars on each of the 5,000 parts made.

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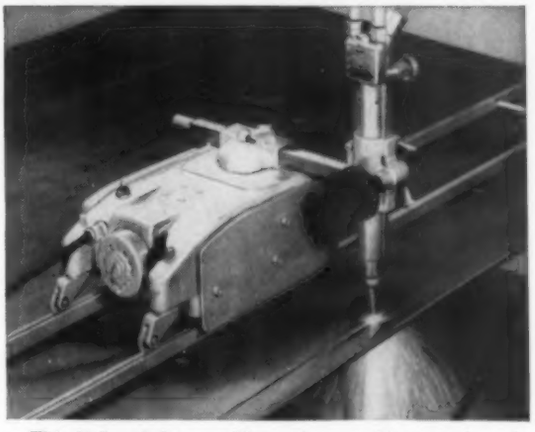
LINDE service engineers will be glad to help you determine the shape-cutting setup to best serve your job needs. Call your local LINDE representative for more information. Start saving now—call him today.



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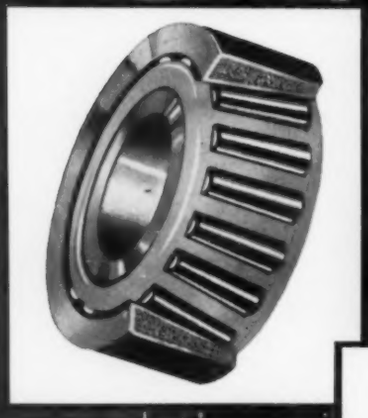

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the general staff supervising all engineering activities for the company. **John F. Kiernan,** chief plant engineer, has been appointed chief engineer and will also be a member of the general staff responsible for plant engineering and equipment in all of the company's plants.

Norvall M. Hunthausen, St. Louis, Mo. district sales manager for the Mexico Refractories Co., has been appointed assistant secretary and treasurer of the Southwest section of the National Open Hearth Committee to succeed **H. W. Gethin** of Laclede-Christy Co., who has been transferred to Pittsburgh.

Paul S. Dickey, former vice president and a director of the Bailey Meter Co., has been elected president succeeding **Robert S. Coffin,** who was elected chairman of the executive committee and named management consultant. Mr. Coffin, with the company since its establishment in 1916, had been president since 1944. **Harvard H. Gorrie,** chief engineer, has been elected a vice president in charge of all engineering activities,

PAUL S. DICKEY

and **Raymond D. Junkins,** head of the patent department, has been elected a vice president and director. **H. M. Hammond** continues as a director and vice president in charge of all sales activities. Mr. Dickey started with Bailey as a cadet engineer in 1925. In 1928 he was assigned to the engineering and research department. He served as chief research engineer, marine control consultant, and was appointed chief engineer in 1944. In 1947 he was elected a vice president. Mr. Gorrie joined the company in 1927. In 1944 he became head of the design department, was appointed assistant chief engineer the following year, and chief engineer in 1953. Mr. Junkins has been with Bailey since 1920. From 1922 to 1925, he was manager of the Boston, Mass., office. He was appointed chief engineer in 1925, and retained that position until 1930 when he was appointed head of the patent department.

Howard F. Kulas, Jr. has joined the Cleveland Metal Abrasive Co. in a management capacity with operating, technical and sales responsibility. Mr. Kulas was plant metallurgist at the Cleveland plant of Republic Steel's Pressed Steel Division for several years. Most recently he was manager of original equip-

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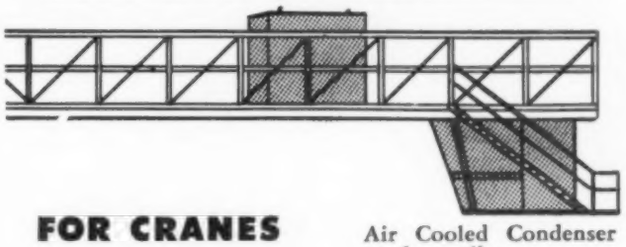

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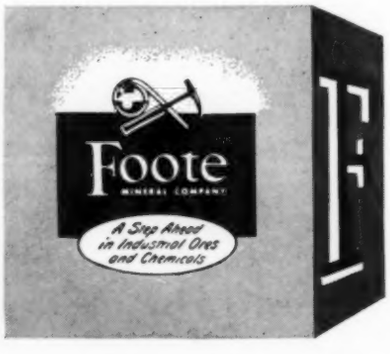

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ment manufacturer sales for the Weatherhead Corp., after serving for nine years in various engineering, production, and sales capacities with that company.

Wayne Belden, was elected president of the Ajax Flexible Coupling Co., Inc. Mr. Belden became associated with the company in 1929 as assistant to the president, and was appointed executive vice president in 1953.

Charles E. Hall was appointed works engineer of both the Cincinnati, Ohio and Taylor, Ky., plants of the Charles Taylor Sons Co.

James F. Magin, vice president and a director of the Square D Co., has been appointed general manager of the company's Industrial Controller Division. Mr. Magin joined Square D in 1946 and was elected a vice president in 1953.

William Neundorfer has been appointed district sales engineer in charge of the newly established Cleveland, Ohio, office of Thermal Research and Engineering Corp.

W. S. Lowe, president of A. P. Green Fire Brick Co. was elected president of the Refractories Institute, at the annual meeting held May 19. **F. H. Laube,** executive vice president of Freeport Brick Co., was re-elected treasurer.

Glen Hartman was appointed assistant manager of operations of Ohio Seamless Tube Division of Copperweld Steel Co. Mr. Hartman was formerly plant metallurgist.

O. A. Olson has been promoted from project engineer to assistant director of research at Laclede-Christy Division of H. K. Porter Co., Inc.

George G. Lindholm, manager of the Chicago, Ill., branch of Crane Co. since 1948, has been appointed manager of the company's valve and fitting department at its general office, Chicago. He succeeds **F. J. Wilkey** who has been named special representative of Crane's industrial sales division. Mr. Wilkey has headed the valve and fitting department since 1944. **Thomas D. Kelly** has been appointed manager of the Chicago branch to succeed Mr. Lindholm. He has been manager since 1953 of the company's Cleveland branch.

Kenneth W. Hansen has been added to the New York office sales staff of Harbison-Walker Refractories Co. He has been associated with the company since 1952, serving in research and technical sales departments.

Jack Grant was named sales engineer by Pennsylvania Engineering Corp. Mr. Grant has worked on machinery design and has been active in the sales of steel mill equipment for the past five years.

Obituaries

Quincy Bent, retired vice president of the Bethlehem Steel Co., died May 5. Mr. Bent, who retired in 1947, began his career in 1901 at Bethlehem's Steelton plant. He moved in 1903 to the Lebanon furnaces where he was named superintendent. Four years later he was named manager of the plant. In 1909 he became assistant to the president of Maryland Steel Co., a Pennsylvania steel subsidiary. Mr. Bent moved back to Steelton in 1909 to become manager of Bethlehem's plant there. In 1918 he was named a vice president of Bethlehem in charge of all the company's steel plants. He retired in 1947 after devoting 47 years to the industry.

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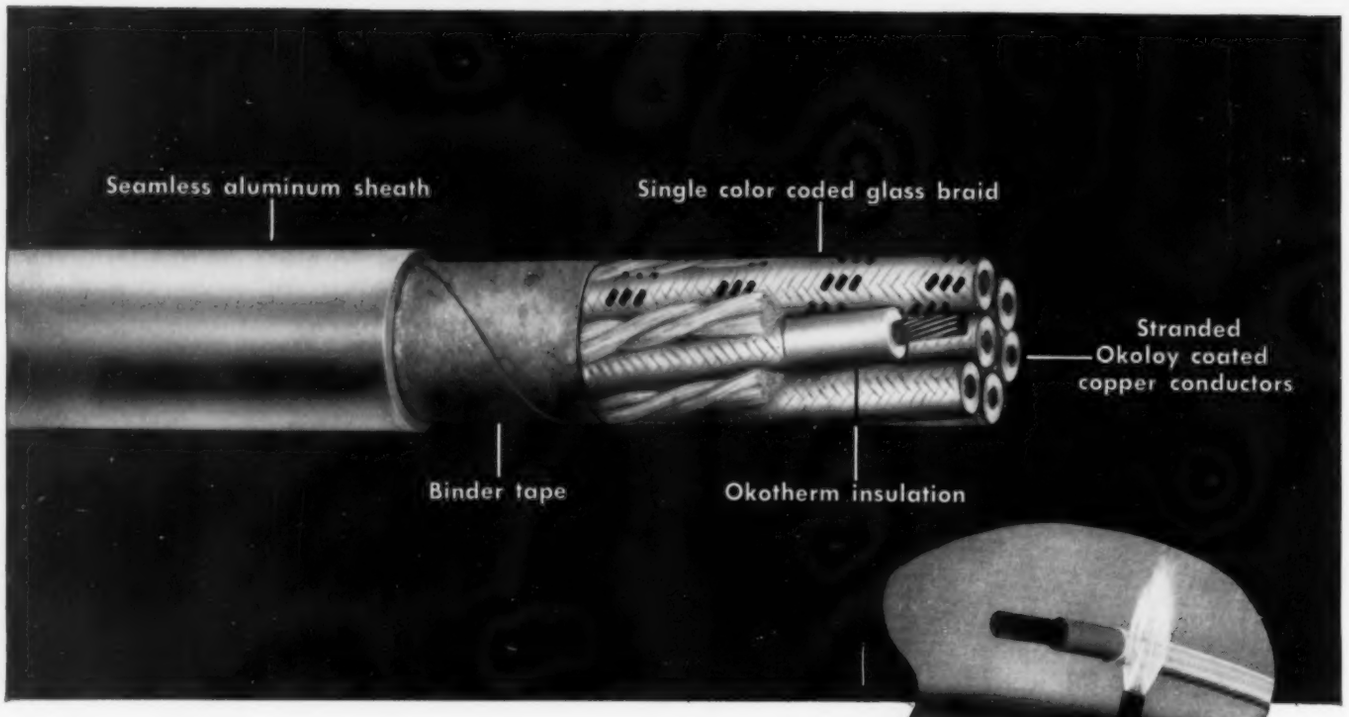

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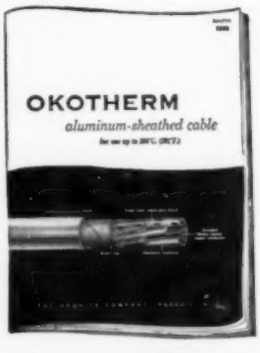

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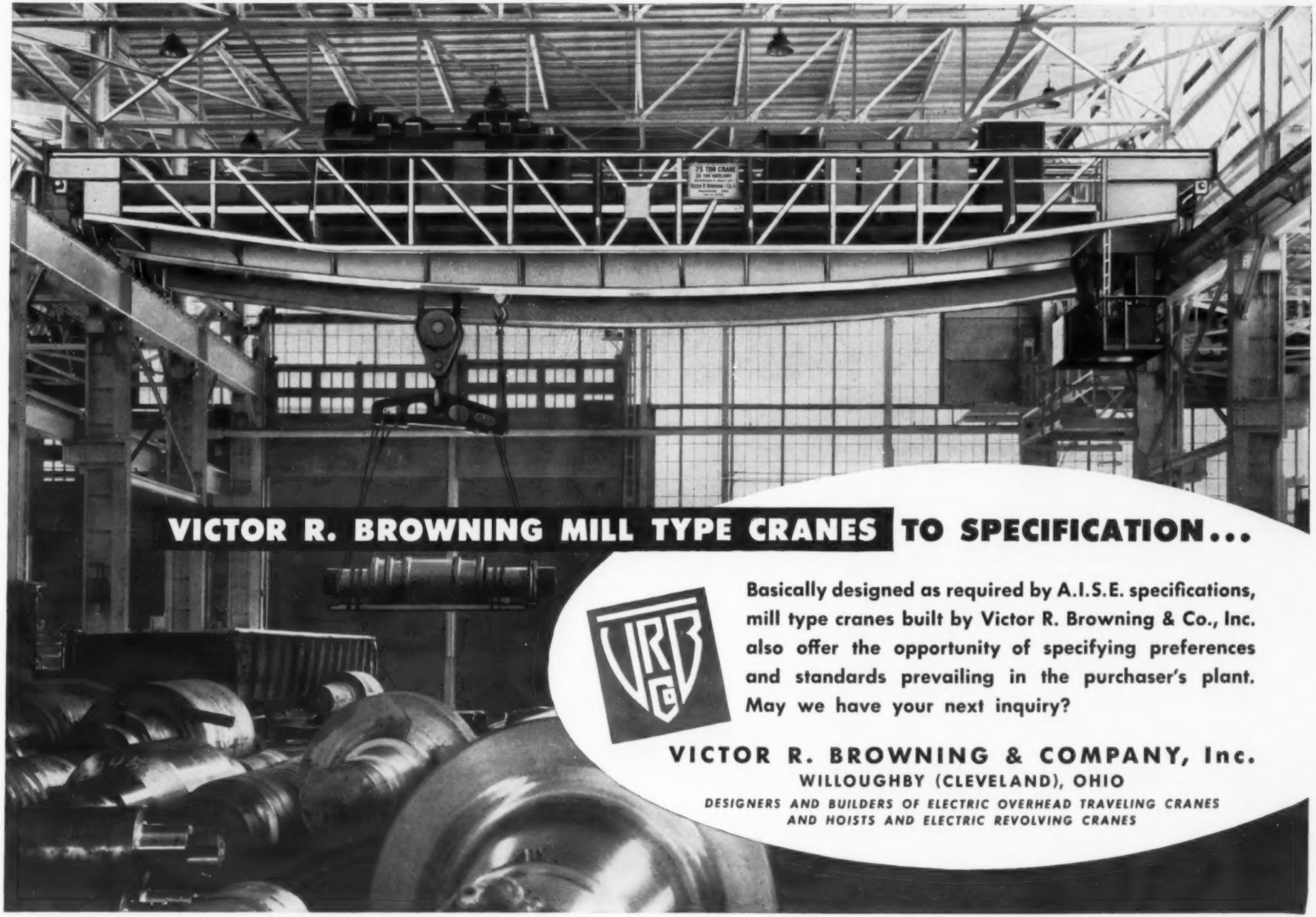
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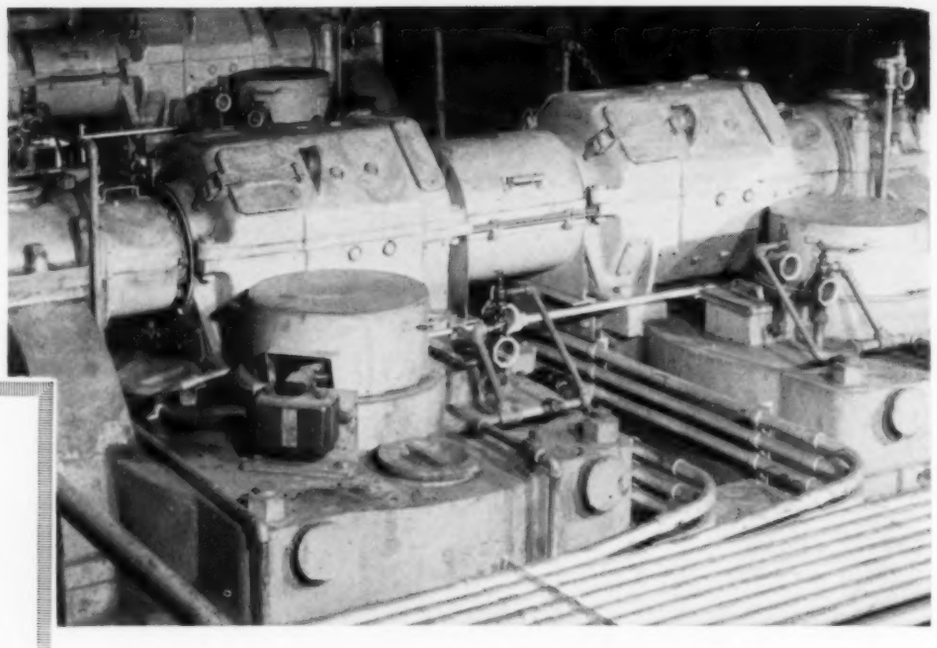

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QUICK-ACTING, high-torque Stearns magnetic clutches engage and disengage screw-down drives with the lowest possible inertia — a prime necessity on today's rolling mills running at speeds often greater than 6,000 fpm. Because of their high efficiency, more Stearns magnetic clutches are used on steel mill screw-downs than all other makes combined. Here are some of the features that have put Stearns out front, and keep it there:

Precision automatic control — Clutches can be operated through push buttons, electric-eye systems, remote switches or manual controls.

Lightweight, compact — Stearns patented multiple friction-disc clutches provide greater torque than bulky, far heavier single-disc types — offer extremely low inertia value to driven end. This is especially important when little or no drifting is desired after clutch is disengaged.

Few wearing parts — No toggles, pins, yokes, shifters to wear and get out of order. Lining wear increases torque, making frequent adjustment unnecessary.

Simple adjustment — No set screws, cams, wedges, spacers or lock nuts. Simply depress adjustment lock-pin, rotate armature to next notch.

Easy access — Can be removed vertically with motor from mill. Housing covering entire unit is split either horizontally or vertically for easy inspection. Magnetic hub is detachable when used on screw-downs.

For improved quality control it will pay you to replace old-style clutches with new Stearns multiple-disc clutches on existing installations . . . specify Stearns for new mills. Write for complete details.

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... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

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(1) Magnets

The construction and application of electro-magnets is the subject of a new booklet published by Cutler-Hammer, Inc. The 24-page booklet pictures and explains the design of their latest all welded type magnets and bolted magnets. A chart of lifting capacities and ratings are included. (EC-88)

(2) Push-Button Teeming

Blaw-Knox Co., has published a bulletin describing an automatic device for teeming ingots. Known as "Autopour," the device is an electrically controlled push-button method which increases safety and improves the pouring practice. The catalog also contains a diagram of the "Autopour," and explains its operation. (Bulletin No. 2496)

(3) Gang Slitters

A new two-color, 24-page booklet describing gang slitters and accessory equipment for warehouse and factory use is available from Waterbury Farrel Foundry & Machine Co. The booklet covers both standard and custom-engineered slitters ranging in size from hand-operated, bench mounted slitters to fully automatic slitting lines. Conventional driven slitters, pull-through slitters, and combination slitters are the three basic types discussed. Included in the catalog are specification tables which give drawing numbers, cutter and spindle diameters, range of metal thickness and the widths in which the machines are generally built. Also illustrated are payoffs and coil boxes, loaders, straighteners, feed rolls, back rolls, cutters and spacers, stripper fingers, various types of scrap disposal attachments, winders and coilers. (Circular No. 898-S-2)

(4) Cranes

Bedford Foundry & Machine Co., has released a bulletin describing all types of their overhead traveling cranes and the utilization of overhead cranes for maximum efficiency and economy. Also included are details of construction and operational features.

(5) Nodular Iron

An eight-page bulletin on nodular iron for rolls and castings has been published by the Aetna-Standard Engineering Co. The bulletin includes an explanation of nodular iron, roll and casting applications, plant production illustrations, and specifications on different types of nodular iron.

(6) Electrical Connectors

Joy Manufacturing Co., has published a 12-page bulletin on electrical connectors. The booklet illustrates and describes the standard styles and adaptations of electrical plugs and receptacles. (No. B59)

(7) Conveyors

Bulk conveyors for handling coal, ashes, sand, gravel, stone, chips, aggregate, etc., are described in a 12-page catalog released by Jervis B. Webb Co. Drawings of cross sections, drive and takeup units, and head and tail ends are shown. Also included are descriptions of belt conveyors, drag conveyors, log conveyors, and wrought conveyors. (Bulletin No. 455)

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50	AJAX FLEXIBLE COUPLING CO.	BULLETIN 58	Dihedral spindle shaft couplings.
51	AMERICAN AIR FILTER	BULLETIN 241	Multi-duty filters.
52	AMERICAN BRIDGE DIVISION, UNITED STATES STEEL CORP.		Types, sizes, capacities, rating, etc., on modern electric furnaces.
53	AMERICAN FLEXIBLE COUPLING CO.	CATALOG 501 & BULLETIN 1052	Fully crowned tooth form couplings.
54	AMERICAN WHEELABRATOR & EQUIPMENT CORP.	BULLETIN 894 & BULLETIN 914	Descaling steel strip and sheets.
55	ASKANIA REGULATOR CO.	BULLETIN 161	Hydraulic edge position control.
56	ATLAS CAR & MANUFACTURING CO.	BULLETIN 1283	Safety type transfer cars.
57	BAILEY METER CO.	SPEC. E12-5	Receiver recorders.
58	BEDFORD FOUNDRY & MACHINE CO., INC.		Mill type cranes.
59	BRISTOL CO.	BULLETIN P1248	Electronic pyrometer controllers.
60	BROOKS OIL CO.		Leadolene industrial lubricants.
61	CLEVELAND WORM & GEAR CO.	CATALOG 400	Worm gear speed reducer line.
62	COLUMBUS McKINNON CHAIN CORP.	BULLETIN 100	Care, use and inspection of sling chains.
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65	DIAMOND POWER SPECIALTY CORP.		Industrial wired television.
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69	DREVER CO.	BULLETIN B-61	Vertical strip continuous annealing furnaces.
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78	JOHNS-MANVILLE CORP.	PK-71A	Oil seals.
79	KOPPERS CO., INC. FAST'S COUPLINGS DEPT.		Detailed descriptions, capacity tables, photographs, etc., on couplings.
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87	ROCKBESTOS PRODUCTS CORP.	SPEC. RSS-88	Test and construction specifications of Rockbestos.
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94	YODER CO.		Slitter operation.

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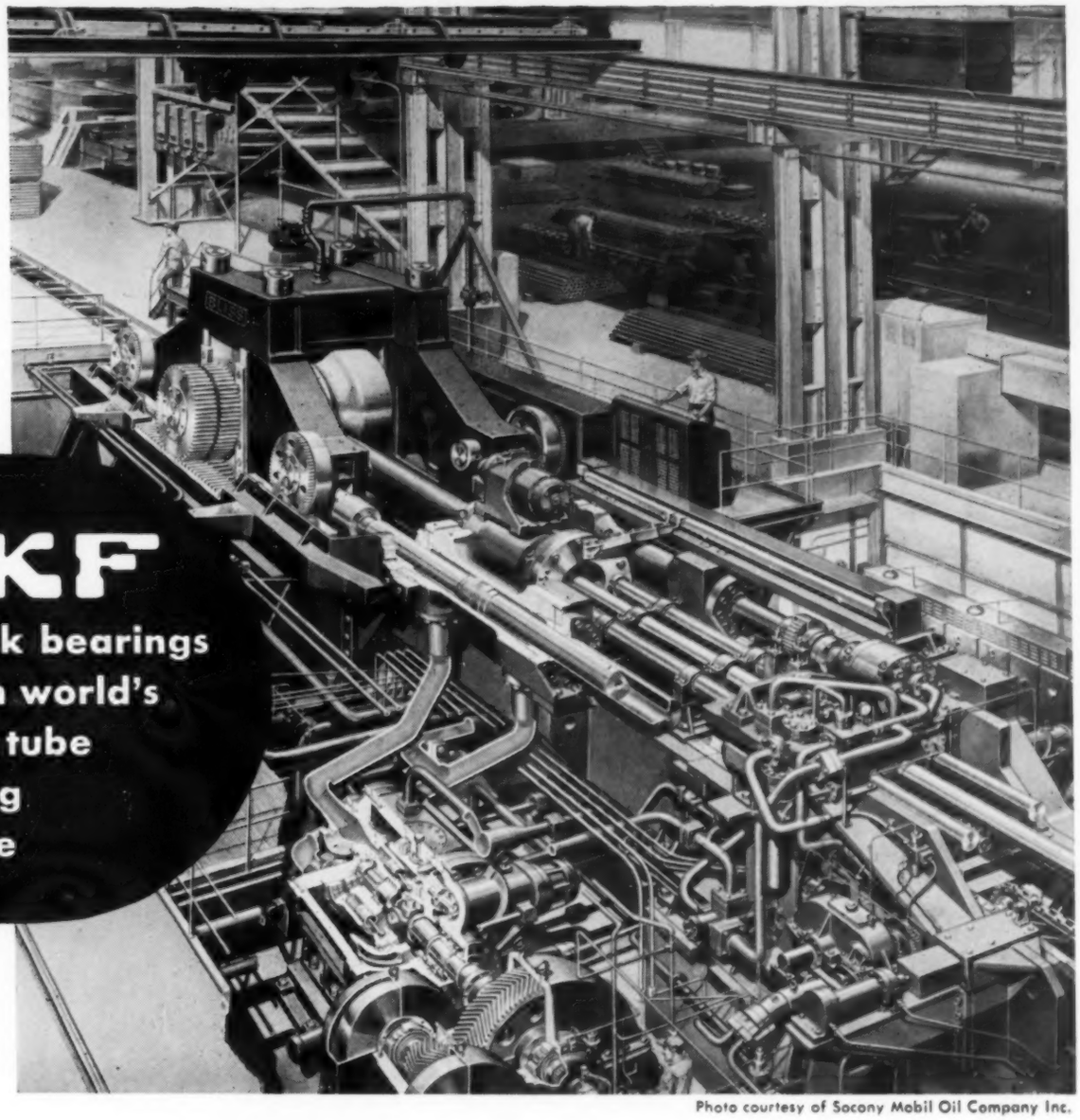

SKF roll neck bearings used on world's largest tube reducing machine

Photo courtesy of Socony Mobil Oil Company Inc.

SKF sphericals absorb tremendous punishment, provide greater bearing capacity

This 102 foot long giant tube reducing machine, designed and operated by Tube Reducing Corporation, Wallington, N. J., for the U. S. Navy Bureau of Aeronautics, and built by E. W. Bliss Company, Canton, Ohio, puts a 3½ million pound squeeze on precision tubing of outer diameter sizes ranging from 9 to 17 inches for military and commercial cold finished tubular products.

The mammoth bearings for 50" diameter rolls on the machine are SKF Spherical Roller Bearings. They are the largest spherical roller bearings of this type ever made, with a rated capacity of 3,200,000 lbs. Each bearing weighs 5150 lbs.; individual rollers weigh 39½ lbs.

The Tube Reducing Corporation first employed SKF Spherical Roller Bearings in 1937 for a 2¼" tube reducing machine having 13" diameter rolls. Today, *all* tube reducers in this plant are SKF-equipped... from the smallest to the 102 foot giant.

Like the men at Tube Reducing Corporation, organizations that pioneer advancements in their fields are accustomed to find that SKF matches their vision with advanced bearing design that helps them make a working reality of their most ambitious and forward-looking plans.

Make SKF Engineering cooperation a *plus* factor in the successful realization of your company's planning and development program. 7651

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA., *manufacturers of* **SKF** *and* HESS-BRIGHT® *bearings.*

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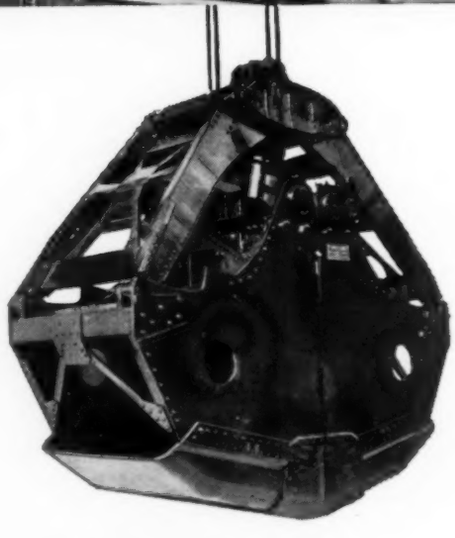
BALL AND ROLLER BEARINGS

UNLOADERS and BRIDGES
for Ore...Limestone...Coal

These three towers, located at a large steel plant in Detroit, provide an impressive illustration of the effective design and sturdy construction of Mead-Morrison equipment. The latest addition to this team of unloaders, the tower in the foreground, is provided with a rotating bucket and a belt conveyor which carries ore from hopper back to trough, making possible an unloading rate of 2000 tons per hour.

From the trough, the ore and limestone is rehandled by Mead-Morrison bridges to the storage pile and the high line feeding the blast furnaces.

Design features in these machines make them outstanding in ease of operation and smoothness of control. Be sure to consult Mead-Morrison on your material unloading and rehandling problems.



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WESTFIELD, N. Y.

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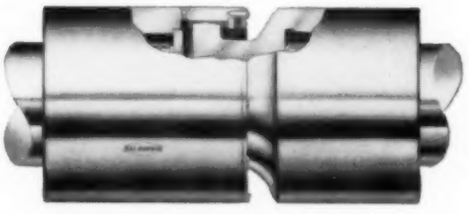
Out of a principle — Ajax developed a vastly improved gear tooth design. The Ajax Dihedral Flexible Coupling for direct connected machines is an exclusive and basically new coupling. It overcomes design, manufacturing, assembly and maintenance troubles which have been taken for granted as necessary evils over the years.

A dramatic example of how Ajax Dihedral Spindle Shaft Couplings are making all other types of conventional couplings obsolete — a two-stand tandem tin temper pass mill designed and built by E. W. Bliss Co., for Jones & Laughlin Steel Corporation... Aliquippa Works, was designed to be the fastest temper pass mill in the world with operating speeds over a mile a minute. Conventional couplings were replaced by Ajax Dihedral Spindle Shaft Couplings and speed was stepped up over 1000 F. P. M.

Manufacturers and operators of rolling mills, paper mills, dredges, cranes, earth moving and other heavy duty machinery are adopting Ajax Dihedral Couplings as standard equipment.

Field-tested for five years. Ajax Dihedral Coupling performance is a challenge to design complacency. For engineering service or further information about Ajax Dihedral Couplings, consult your telephone directory or write the Ajax factory for Bulletin 58.

Tear out this coupon and mail today!



Cut away view of Ajax Dihedral Spindle Shaft Coupling.
Patents Pending

AJAX FLEXIBLE COUPLING CO. INC.
Westfield, New York, Dept. B-58

Send me Bulletin 58 on the application
of Ajax Dihedral Spindle Shaft Couplings.

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WESTFIELD, N. Y.

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CHARLES R. COX

Portrait by Fabian Bachrach

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"I know of no better method for each citizen to protect the American way of life than by building his own economic security and by helping his Government to keep financially sound. Both these results can be accomplished through the Payroll Savings Plan. I urge every executive in the nation to give this Plan his active and vigorous support."

CHARLES R. COX, *President, Kennecott Copper Corporation*

With the active cooperation of Mr. Cox, Kennecott conducted a person-to-person canvass which put a Payroll Savings Application in the hands of *every* one of Kennecott's 20,000 employees. The men and women of Kennecott did the rest. Country-wide participation in Kennecott's Payroll Plan rose from 24% to 52%.

Your State Director, U. S. Treasury Department, is ready to help you install a Payroll Savings Plan, or show you how to build participation in an existing Plan through a simple person-to-person canvass. Write today to Savings Bonds Division, U. S. Treasury Department, Washington, D. C.

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. . . does it efficiently, and economically. Notice that the gases and fumes do not pass through the fan. Cold air shot through a Venturi tube creates a vacuum that draws the fumes, mixes them with the cold air and releases them to the atmosphere at reduced temperatures.

The Morgan Ejector is operating efficiently in many installations. It has proved that it can do a tremendous job at relatively low cost. Let us tell you more about it.

CCC-37

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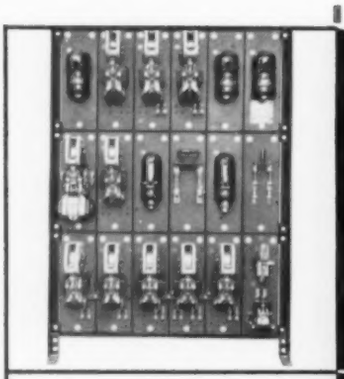
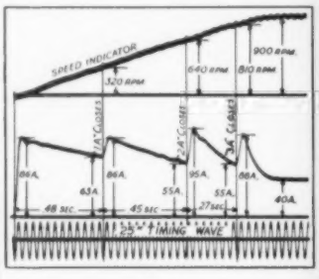
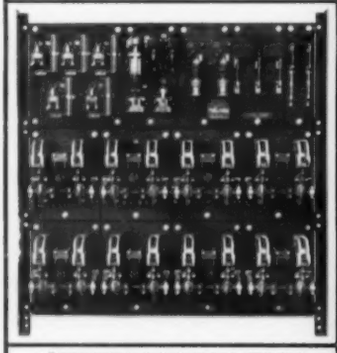
Earned... a reputation for **engineered** control for every make and type of crane



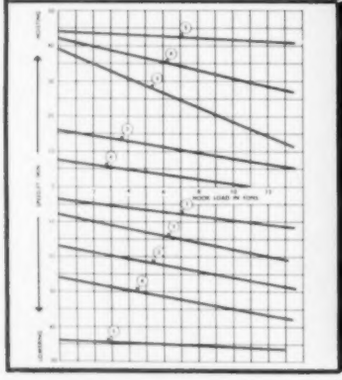
EC&M **Wright Circuit** Dynamic Lowering Controller is a simple, easily understood, completely safe system for D-c Cranes.



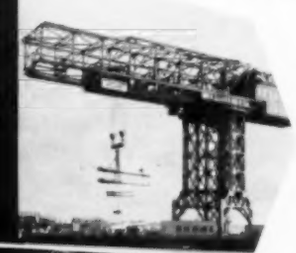
EC&M **Frequency Relays** accelerate A-c motors smoothly. They also accurately control plugging and speed-limiting functions.



EC&M **Contra-torque** Control for A-c Bucket Cranes improves operation with faster getaway . . . wider speed selection . . . smoother stopping.



EC&M **Eddymag** Hoist Control for A-c Cranes provides precise hook speeds for precision handling.



When crane control problems are tough, experienced crane users turn to **EC&M**. They know that the extra margin of safety and accurate engineering result in quick, efficient operation, lower upkeep costs and freedom from delays.

At **EC&M**, the control for every crane is "specific". The crane data sheet serves as the blueprint for matching control equipment to actual crane loading. Relay-settings . . . resistor fillings . . . contactor sizes . . . and brake windings are designed to assure top performance.

Make it a point to specify **EC&M** Control for your next crane.

6216

THE ELECTRIC CONTROLLER & MFG. CO.

4498 Lee Road • Cleveland 28, Ohio

Equipment News...

WELD APPLICATIONS

▲ A new automatic submerged-arc welding process which will deposit metal up to five times as fast as comparable welding methods and at half the power cost, is in final stages of development at Alliance, Ohio, Research Center of the Babcock & Wilcox Co. Known as the I²RT method, the new process is applicable to submerged arc welding, in which the bare electrode is fed through a layer of granular flux and to inert gas shielded welding. Standard submerged-arc welding practices have been based on the principle that deposit rate is directly proportional to the diameter of the electrode.

Cross section of welded butt joint employing I²RT submerged arc welding process developed at the Babcock & Wilcox Co.'s research center in Alliance, Ohio. Joint is in a three in. thick SA-212 steel plate at a deposit rate of 180 lb per arc hr. Present day normal production rates with other methods of automatic weld deposition are 17 to 20 lb per arc hr.

This theory holds true with flux-coated electrodes, where current density is limited. However, B&W found that desired weld patterns could be made at deposit rates that were inversely proportional to wire size for a given current. In one case, for example, a higher deposit rate was obtained with a $\frac{3}{32}$-in. diameter electrode at 650 amp than with a $\frac{1}{4}$ in. electrode at 800 amp.

Experiments subsequently revealed that the deposit rate at high current density is directly proportional to the length of the electrode wire from the contact shoe to the arc.

This discovery led to the I²RT principle of submerged-arc welding. The new process preheats the electrode almost to its melting point before it enters the arc. Thus the arc does not have to supply the sensible heat required to bring the metal to the melting point, as it does in standard submerged-arc processes. Practically all the energy absorbed by the electrode at the arc supplies heat of fusion to melt the metal.

The new welding technique uses higher current densities than existing welding methods. For example, current density in electrodes varies from 70,000 to 270,000 amp per sq in., as compared with 10,000 to 20,000 amp per sq in. using other methods. Only with submerged-arc welding and inert gas welding are these ranges possible, since high current densities damage flux-coated electrodes.

B&W is currently using carbon-steel wire electrodes with tensile strengths of 70,000 psi for production work. Experiments, however, have been made with alloy electrodes, since electrical resistance of the alloys is higher.

In operation, a voltage sensitive relay controls the length of electrode projecting from the nozzle. Changes in the load voltage are received by this relay, which signals the raising or lowering of the weld head.

Granular flux, through which the wire is fed, is composed of finely divided metal oxides with a depth of about 1 to 1½ in. To keep pace with the fast deposition of metal, B&W engineers have developed a special guiding device that keeps the weld head and arc trued up with the work. Beads are deposited too fast for accurate manual guiding.

Advantages of the I²RT technique are:

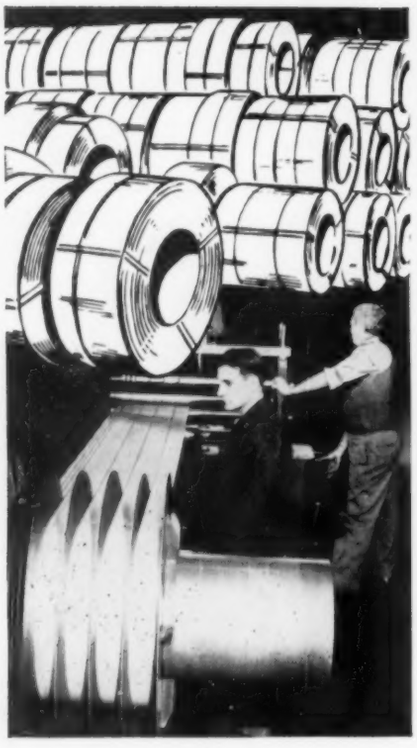
1. *Faster*—Using a current of 1000 amp, welding can deposit metal up to 100 lb per hr compared with commercial welding processes of 30 lb per hr with the same current.

2. *More Efficient* — In standard automatic welding systems, only 20 per cent is actually used to melt the electrode. With the new B&W process, all energy is applied directly in the electrode to heat the wire.

3. *Melts Less Base Metal*—Standard welding systems melt base metal and filler metal (electrode) in a ratio of about seven parts of base metal melted to three parts of the electrode. I²RT welding melts about twice as much filler as base metal.

4. *Costs Less* — B&W estimates that actual welding costs will be cut in half by its new method. Test re-

Wire electrode is fed through granular flux during welding operation. Before entering the arc, the electrode is preheated to almost its melting point. Weld head and arc are trued up with special guiding device.



A Versatile

Low-Cost Slitting Line

● Production records covering a 3-month period in one plant revealed that one comparatively small, inexpensive Yoder Slitting Line, (No. 2½, 24" wide) had been successfully used on a wide diversity of jobs.

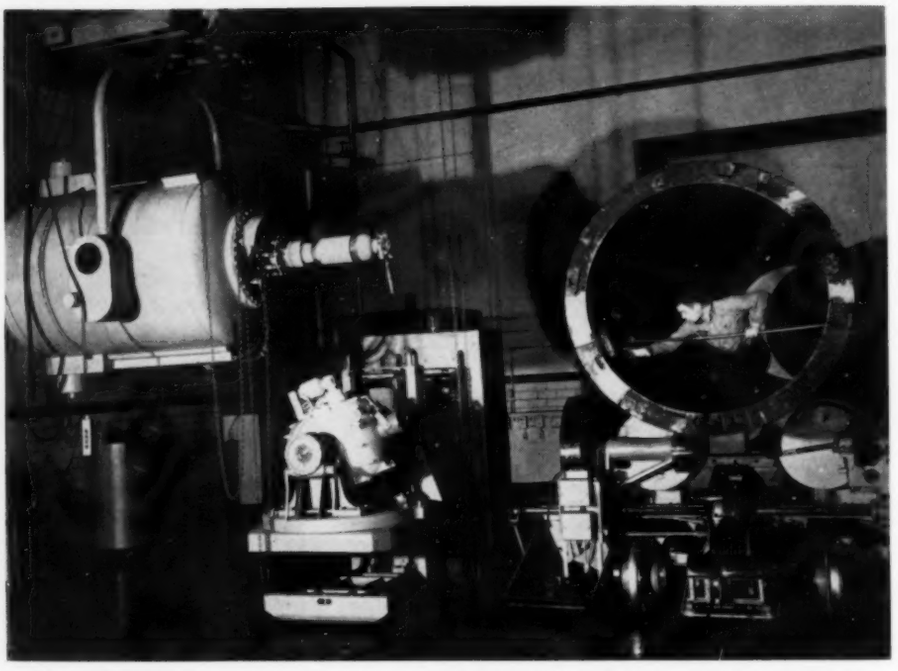
Coil weights ranged from 4082 lbs. all the way down to 80 lbs.; production from 11,135 lbs. down to 629 lbs. per hour, varying with coil size, number of cuts made to the width, and gauge of strip.

The 4th edition of the YODER SLITTER BOOK, just off the press, gives more complete data on each of these jobs, and in addition discusses many subjects bearing on the mechanics and economics of slitter operation, in plants using anywhere from 50 tons per month up to a thousand or more. A copy is yours for the asking. Also estimates and recommendations, without cost or obligation on your part.

THE YODER COMPANY
5495 Walworth Ave. • Cleveland 2, Ohio

Rotary Gang SLITTERS

ENGINEERING YODER MANUFACTURING



The "Isoscope" is radiographing the thick steel walls of a typical pressure vessel The two million volt x-ray machine is suspended from the ceiling to the left of the "Isoscope."

sults show that I^2RT uses 0.65 kwhr per lb of electrode and comparable methods consume approximately 1.2 kwhr to weld the same amount of filler.

The I^2RT welding method can be adapted to existing welding systems, and would consist mainly of installing suitable transformer capacity and increasing the rate of feeding the wire electrode. In some cases larger or additional transformers would be required, since the new process needs double the load voltage formerly required. Travel speeds would also have to be increased.

Another recent development of importance to welding operations is a new unit to check the soundness of welds.

Radioactive Cobalt 60 is utilized in a new inspection tool which is capable of radiographing thickness of steel up to seven in. Developed by the Babcock & Wilcox Co., the unit has been christened the "Isoscope." It has been under study and development by B&W for the past three years, requires only one-third the exposure time of a million volt X-ray unit, and paves the way for wider use of atomic energy in this industrial application.

The lead sphere of the "Isoscope" is encased in a steel jacket having a cylindrical rotor section built into it. By revolving the rotor 180 degrees the radioactive source can be brought from the "safe" position to a point in line with the coned opening in the steel jacket allowing a beam of radiation to escape. This, in effect, results in a unit which can be turned "on" and "off."

The total charge placed in this unit was 1008 curies of Cobalt 60. The charge is comprised of small discs stacked one on top of the other like coins in a coin changer. The radiation is taken from the top of this stack so that the focal spot size compares favorably with existing high voltage X-ray equipment.

The balance of the "Isoscope" consists of a modified electric platform lift truck having a "lead cab" built on the back and a "turn-table" mounted on the front platform. Trunnions on the turn-table receive the lead ball containing the radioactive material. Cover plates mounted on top and bottom of the lead balls carry the cylindrical rotating mechanism. This assembled unit can be raised or lowered through eight ft, rotated vertically through 210 degrees and horizontally through 360 degrees.

The lead cab provides protection for the operator and contains controls for the operation of the machine. The controls consist of a timer, an "on"–"off" button and a green, amber, and red light system which informs the operator of the position of his source at all times.

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what's new at BRISTOL...

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Free-Vane® Electronic Pyrometer Controllers

A new development in automatic temperature control

featuring...

● **A UNIQUE ELECTRONIC CONTROL SYSTEM, which gives a new quality of automatic control.** The controller is extremely stable, rugged, and sensitive. Very minute changes in the measured quantity at the control point (less than 0.003" on the scale) closes or opens the Thyratron-operated relay with positive trigger action, making it impossible for the relay to flutter or chatter. Control action is unaffected by changes in ambient temperature, line voltage, or wide variations in tube characteristics.

● **A NEW MILLIVOLTMETER MECHANISM for greater accuracy.** High-torque, rugged, jeweled mechanism has 30 ohm coil, Alnico 5 magnet, a sensitivity of 15 ohms per millivolt. All ranges are critically or over damped.

● **OUTSTANDING MECHANICAL DESIGN for easy installation, interchangeability, and simplified servicing.** All units, including pyrometer unit, electronic control unit, and proportional-input unit are separate. The electronic control and proportional-input units plug in. No routine adjusting or attention needed. Series 536 Indicating Free-Vane Electronic Pyrometer Controllers are available as thermocouple and radiation pyrometers in ranges up to 4000° F. for L, H, LH, HOH, and LNH control and for L and H with proportional input control. Write for Bulletin P1248. The Bristol Company, 123 Bristol Road, Waterbury 20, Connecticut. 3.10

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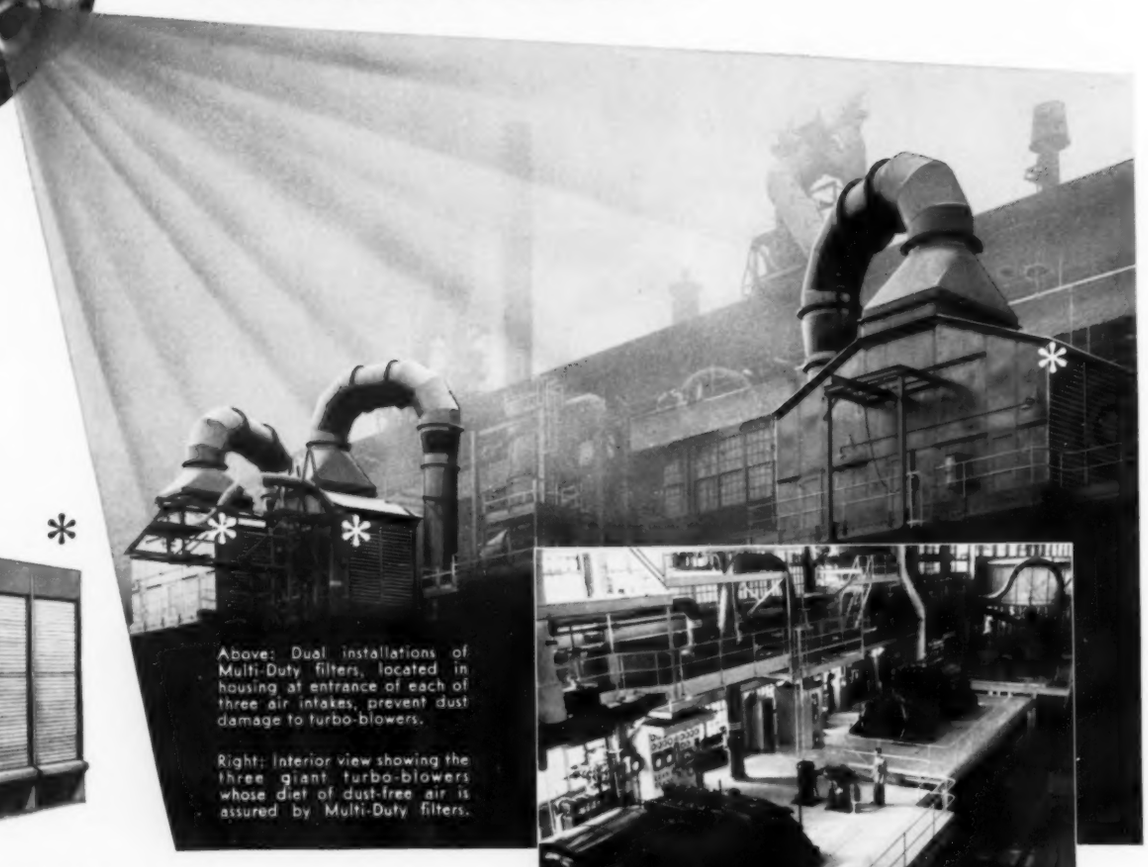
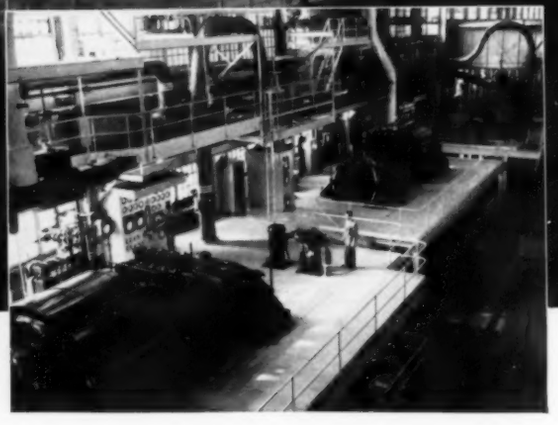
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

How to whip up a wind storm WITHOUT DUST!



Above: Dual installations of Multi-Duty filters, located in housing at entrance of each of three air intakes, prevent dust damage to turbo-blowers.

Right: Interior view showing the three giant turbo-blowers whose diet of dust-free air is assured by Multi-Duty filters.



Multi-Duty Filters Insure Clean Intake Air For Trio of Giant Turbo-Blowers

THE three massive turbo-blowers shown in inset supply the combustion air for the blast furnace operations at this large Eastern steel mill. The air they swallow must be free of dust or these minute abrasive particles will quickly wear their impeller blades—and that means "down time" that's measured not in cost of repairs but in dollars of vital steel production lost.

Here, as in scores of other steel mills, AAF Multi-Duty was assigned the all-important air cleaning job. This automatic, self-cleaning filter is designed for constant efficiency and uniform air cleaning regardless of the dust load. It works every shift without supervision — requires no attention other than periodic inspection and removal of sludge at regular intervals.

For complete information on the Multi-Duty and its "work record" in the steel industry, just call your local AAF representative or write direct for Bulletin 241.

AAF

herman nelson

American Air Filter
COMPANY, INC.

American Air Filter of Canada, Ltd., Montreal, P. Q. • 302 Central Avenue, Louisville 8, Kentucky

tages of this unit over high voltage X-ray equipment, as brought out in the announcement, are as follows:

1. Lower initial cost.
2. Less amount of shielding necessary for secondary radiation.
3. Greater mobility.
4. The maintenance and operating costs are a known factor and can be predetermined. This predetermination cannot be accurately made for the one and two million volt radiographic equipment.
5. A mechanical breakdown would not stop the examination being made since the "Isoscope" may be operated manually and the examination completed before mechanical repair is attempted.
6. The simplicity of controls eliminates the need of a highly trained technician for operation of the equipment.

LIFT TRUCK

▲ An industrial lift truck consisting of one mast has been announced by Hyster Co.

Known as the "Monomast," this truck panoramic visibility allowing the operator a clear, unobstructed view to both forks and load, permitting faster operating speed and reducing driver fatigue. Additional operating advantages offered are faster maneuverability, faster approach, more accurate load placing and safer load handling.

Total weight of the truck upright is about the same as standard type assemblies, but its tubular design is acknowledged to be even stronger than comparable models. Torsional rigidity in the mast has been increased 80 per cent and mast deflection reduced 50 per cent over conventional upright or mast assemblies.

The design allows a 15 per cent increase in hoist speed. Load raising speed is now 58 fpm with a corresponding increase in load lowering speed. Slight horizontal carriage flotation is a desirable feature which permits the lift truck to angle back out of tight positions after load depositing.

A piston-type cylinder with a new self-adjusting packing gland minimizes possibility of oil leagage and extends packing life. Life of cylinder and packing is also extended by full protection from dirt and mechanical damage.

HEATING UNIT

▲The High Frequency Division of Lindberg Engineering Co., has announced a new 3 kw high frequency induction heating unit for brazing, soldering, hardening, and other light heat treating applications. The unit may also be used for quickly melting small quantities of ferrous and nonferrous metals for spectroscopic analysis in research laboratories.

The all steel cabinet is heavily constructed of angle frame and 10 gage steel panels to protect internal components from damage and minimize radio frequency radiation. A double compartment shields high frequency oscillator from d-c power supply and controls. Ample space is provided for safe operation of high voltage components and easy access to all internal parts. Protection of personnel from high voltage is accomplished by means of interlocks on all access doors.

Protective devices include line and control circuit fuses plate and grid overload relays. Complete timing control is made possible by a precision synchronous timer furnished with the unit. All operational controls are accessible from the outside of the unit.

Heavy duty industrial type vacuum tubes are used throughout with oscillator tube air cooled to eliminate large volume water requirements. Filament voltages to all tubes are automatically controlled by voltage regulating transformers.

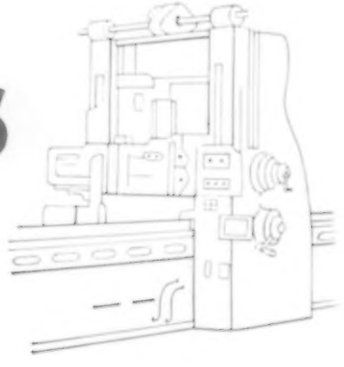
A supervisory system of "checklites" maintains a constant check on air flow, high voltage door, interlocks, grid and plate overload and other operating conditions. These externally mounted lamps instantaneously reveal any abnormal conditions, when they exist, at any of the protective devices.

SHEET LIFTER

▲ Developed by Heppenstall Co., is a motorized sheet lifter with arms that move in and out in a straight line, rather than in an arc.

Because the arms remain vertical at all times, there is no need for manual adjustments when changing from

LET SIMMONS REBUILD AND MODERNIZE YOUR PLANERS



Investigate the important production, maintenance and tax savings of SIMMONS ENGINEERED REBUILDING for your: Lathes, Planers, Surface Grinders, Cylindrical Grinders, Vertical Millers, Openside Planers, Automatics, Vertical Boring Mills, Turret Lathes and Radial Drills.

A qualified Simmons rebuilding engineer will discuss it with you. Write, wire or phone today. Simmons Machine Tool Corporation, 1712 North Broadway, Albany 1, N. Y.

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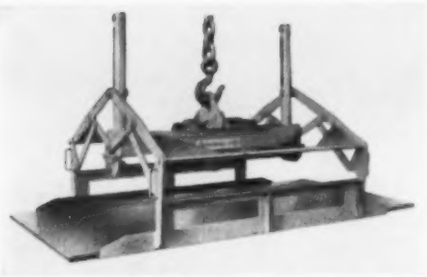

one size sheet to another. All operations are controlled by the craneman. After the lifter has been lowered over a lift of sheets, operation of the motor causes the arms to move in until they hold the load firmly. A self-locking brake prevents the arms from moving until the load is safely delivered. The motor is then operated to move the arms out, releasing the load.

Headroom requirements are less than with other designs, because all waste motion required during opening and closing is taken up by sliding pivots that move up and down on either side of the crane block.

End grabs for use with very wide or very long sheets can be added as optional equipment. If desired, a motorized rotating mechanism can be incorporated with the lifter, permitting it to be turned horizontally to any desired direction under control of the craneman or ground crew.

INGOT INSULATION

▲ A special insulating material, applied in either top or bottom pouring of ingots, has been developed by E. F. Houghton & Co.

Known as "Lapix," it is a finely powdered amorphous material which is applied while the metal is still molten. It is easy to use, does not smoke, fume or give off odors.

Used in small amounts, the material prevents the formation of a crust or bridge, keeps the metal molten for a longer period and allows gases and segregates to rise to a greater concentration near the surface, to help produce better quality steel. It greatly reduces the formation of secondary pipe and has increased ingot yield as much as 3 per cent in some cases.

PLI WASHER

▲ Manufactured by Standard Pressed Steel Co., is a new preload indicating device which makes possible lighter, tighter and longer-lived structural bolt connections.

Known as PLI washer, it is a compact assembly of two concentric steel rings, one of which is compressed as the bolt is tightened. The new washer provides an accurate, virtually fool-proof means for tightening bolts to predetermined preloads as high as 80 per cent of bolt yield strength.

This high preload is almost twice the average preload that is ordinarily induced with torque wrenches, the most commonly used means for controlled tightening of fasteners.

Since in dynamically loaded structures the higher the initial preload, the greater the life and design strength of bolts in fatigue, the PLI washer will permit use of fewer bolts or smaller bolts for a given load in many applications.

RUNWAY SAFETY UNIT

▲ Announced by Femco, Inc., is a new safety system for crane runways.

Developed primarily as a safety device, the new system permits workers to attend to a disabled crane without danger from other cranes

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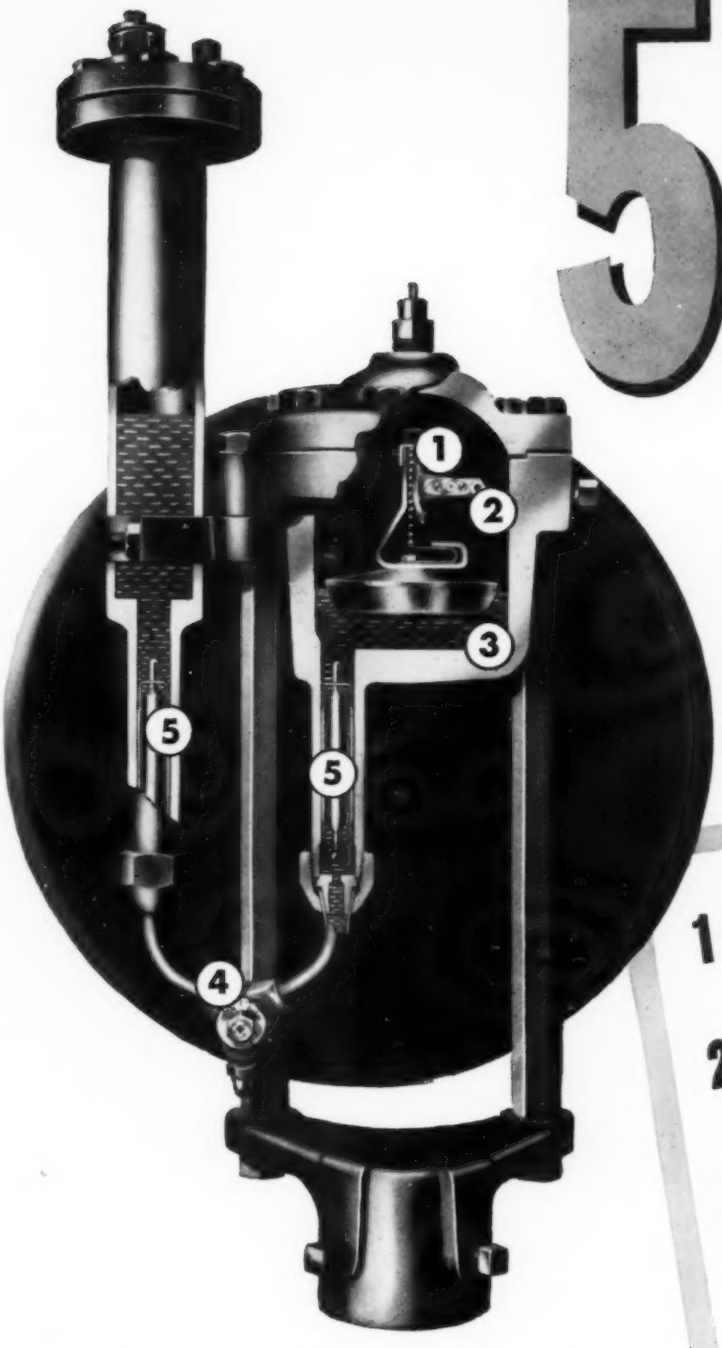
5 basic advances that mean BETTER FLOW METERING!



1 New Segmental Drive Assembly — stainless steel ball-type chain insures perfect alignment and friction-free travel of float.

2 New Pressure-Seal Bearing — stainless steel with exclusive seal ring . . . gives unmatched freedom at any working pressure from friction, maintenance and leaks. No lubrication required.

3 New Compact Float Chamber — greater accessibility for easier, quicker cleaning.

4 New U-Bend and Damping Plug Assembly — self-aligning, all-welded construction . . . no gaskets required. Calibrated damping plug fully adjustable under pressure. Directed drain for mercury at lowest point.

5 New Check Floats — with positive-seating stainless steel ball plug. Submerged in mercury for complete protection against dirt and corrosion.

With major improvements in every basic detail, the complete new line of Foxboro Flow Meters now gives metering performance that's farther ahead of the field than ever before!

In addition to the outstanding advances illustrated, these new meters incorporate many other superior features, including: interchangeable parts; large floats with long travel for added power; and float in high pressure chamber to minimize ambient temperature effects.

Write for new Bulletin 460. It describes the complete new line . . . indicators, recorders, controllers, transmitters . . . with round or rectangular cases . . . with and without integrators. The Foxboro Company, 586 Neponset Ave., Foxboro, Mass., U.S.A.

FOXBORO
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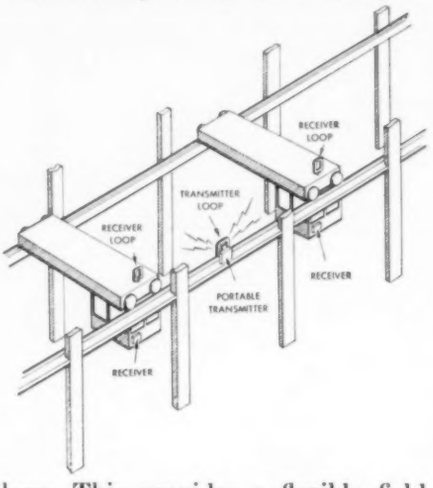
First in FLOW METERS

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

approaching on the same runway. The system automatically gives warning of the approach or shuts off the movement of an oncoming crane. Distance at which the warning or shut-off action is effective is adjustable from one to 20 ft with the proper setting made at time of installation.

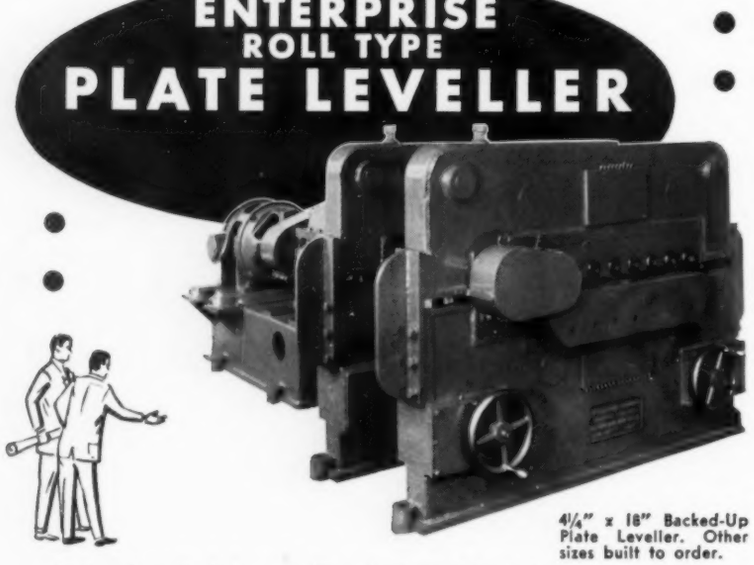
Equipment consists of a compact receiver and receiver loop for each crane or other fixed location and a portable transmitter with transmitter loop to be positioned wherever temporary protection is required. The transmitter and receivers are tuned to the same carrier frequency. At a predetermined proximity, sufficient energy is transferred from one to the other to actuate the impulsed receiver by the high steady output of the transmitter.

All of the equipment is designed so that any failure of any part will cause a warning signal instead of a mute shut down. A sensitivity control on each receiver determines the distance at which the receiver relay is held energized by the transmitter



loop. This provides a flexible field adjustment for setting the warning to become effective at any desired distance.

ENTERPRISE
ROLL TYPE
PLATE LEVELLER



4¼" x 18" Backed-Up Plate Leveller. Other sizes built to order.

Designed particularly for rolling sheet or plate in the metal stamping industry. The heavy box construction with proper work and back-up rolls levels plate up to ¾" accurately—and also removes scale. Quality material and construction throughout—such as bronze worm gears and work roll bearings, anti-friction back-up roll bearings, hardened alloy steel work rolls and gears—guarantee long life and troublefree performance. Get the complete story—ask for Bulletin No. 402.

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MACHINERY BUILDERS & ENGINEERS
SUBSIDIARY OF WM. K. STAMETS COMPANY · PITTSBURGH
COLUMBIANA 1, OHIO · U. S. A.

SWITCHGEAR

▲ A new line of low-voltage, metal-enclosed switchgear, available in indoor and outdoor arrangements, has been announced by Allis-Chalmers Manufacturing Co.

The switchgear features new circuit breakers rated 600 amperes, 25,000 aic at 600 volts (LA-25), and 1600 amperes, 50,000 aic at 600 volts (LA-50).

Reversible panels are mounted on each breaker compartment which permit the doors to be closed with breakers in the connected, test or disconnected position.

Each breaker compartment is barriered from the bus compartments independently of the breaker frame and from adjoining breaker compartments by a double steel wall.

The bus in each individual switchgear unit consists of a set of vertical risers braced with strain insulators to withstand the mechanical forces exerted by short circuit current. The main bus is supported by these risers in each unit and additional bracing is accomplished by strain insulators between phases.

The outdoor unit has a weatherproof housing and a wide unobstructed aisle between the exterior panel and the front of the breaker compartments. This walk-in aisle protects the operator from adverse weather conditions and is wide enough to permit breakers to be withdrawn within the structure. An optional overhead rail-mounted circuit breaker handling device travels up and down the aisle, permitting easy handling of the breakers.

GENERATOR-TYPE WELDER

▲ Westinghouse Electric Corp. announces a new line of gasoline engine driven generator-type welders. Available in current ranges of 30 to 350 amp, a-c or d-c, the new welders are compact, completely self-powered and may be equipped with optional running gear.

One d-c model is a dual purpose unit which not only handles all types of d-c welding but can also be converted into an a-c power plant by a conversion switch. The a-c model also has a 110-volt d-c outlet for operating universal drills and lights. Another model is equipped with high frequency so that it can be used for Heliarc inert gas welding. All the models have infinite current adjustment steps.

ROLLWAY BEARINGS

COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

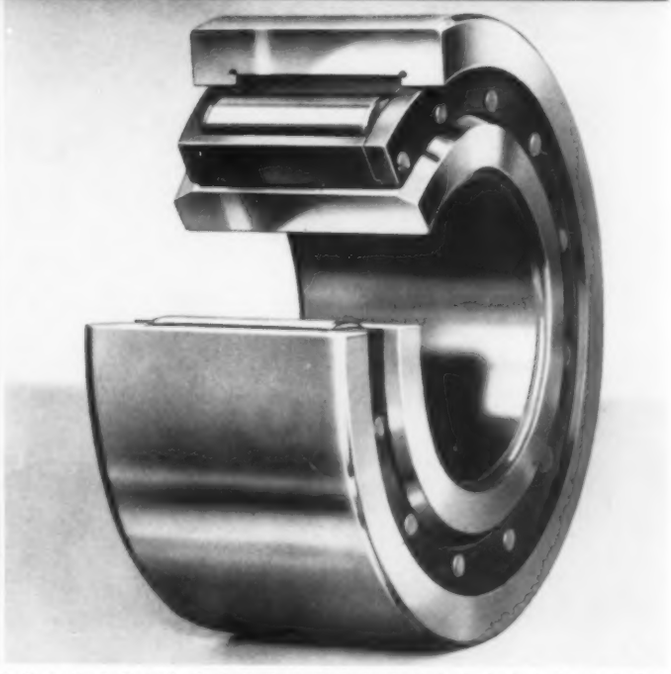
are Recommended by Bearings, Inc.

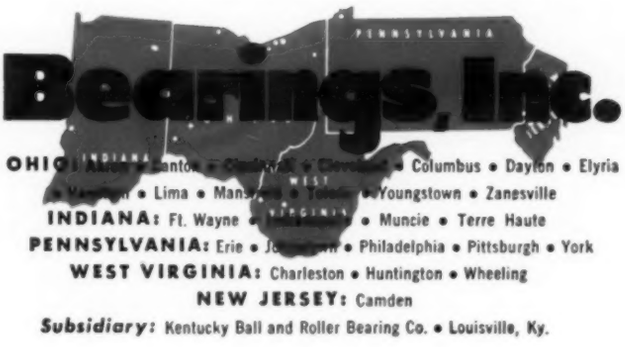
for Longer Life Under Severe Steel Mill Operating Conditions!

In steel mills — in industrial installations requiring rugged, long life bearings designed for heavy load conditions — for resistance to heat and dirt, ROLLWAY Bearings are recommended and sold by BEARINGS, INC. We know Rollway Bearings will outperform many bearings now in use — and that they will be economical in the long run. Bearings, Inc. Sales Engineers know where Rollway Bearings can best be installed — use the coupon below and get quick help on bearing problems!

THRUST TYPE T *A flat seat, single-acting thrust bearing especially suitable for applications where space is limited and heavy load capacity is needed. Under certain conditions they are used over a wide speed range.*

RADIAL TYPE MUC *Has channel type outer race which retains roller assembly and a completely separable inner race. For applications where shaft must be removed frequently leaving the outer race and roller assembly in the housing.*





Bearings, Inc.

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Vermilion • Lima • Mansfield • Toledo • Youngstown • Zanesville

INDIANA: Ft. Wayne • Indianapolis • Muncie • Terre Haute

PENNSYLVANIA: Erie • Johnstown • Philadelphia • Pittsburgh • York

WEST VIRGINIA: Charleston • Huntington • Wheeling

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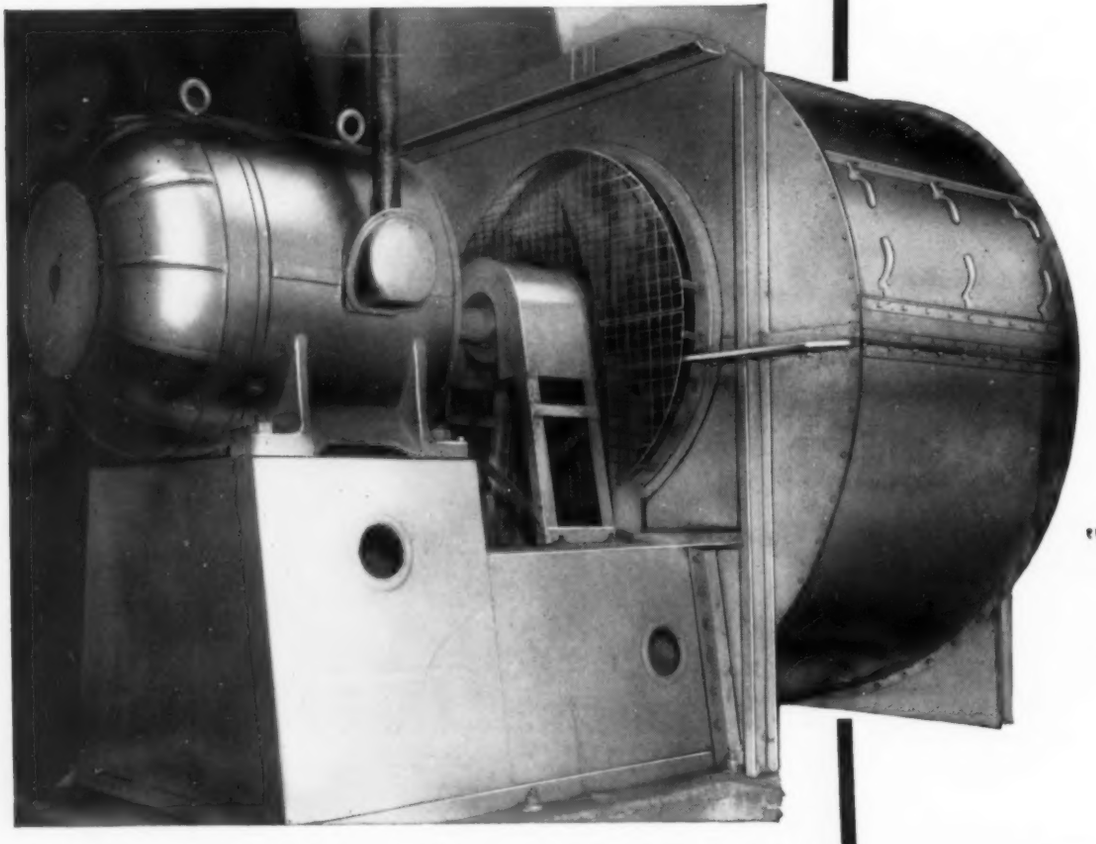
PROTECTIVE C-O-O-L-I-N-G FOR YOUR MILL MOTORS

It takes tremendous volumes of air to keep mill motor temperatures in line! This cooling job calls for fans that can keep delivering under severe conditions of heat and pressure — "Buffalo" Mill Motor Fans.

These fans are "built up" to the job. Rotor blades are of heavy-gauge plate — stiff and strong. Housings are equally rigid and sturdy. Shafts are turned from solid alloy steel forgings. Rotors are dynamically and statically balanced, and have massive hubs. Bearings are oversize. It's all part of the famous "Q" Factor* that has made "Buffalo" a best fan buy for 78 years. Don't leave an important job like motor cooling to chance — specify "Buffalo."

*The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.



This "Buffalo" Fan cools motors continuously and dependably in a prominent mill. Write today for details on these fans built for the long run!

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VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING
FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING

The gasoline engine is an air cooled, four-cylinder, 20-hp Onan model CW. It has electric starting and an internal fly-ball governor with a variable-speed control attachment.

TRANSFORMER UNIT

▲ A new current transformer designed for indoor service and suitable for operating relays and control devices has been announced by the General Electric Co.

Designated as Type JKS-3, it has been designed with extra high mechanical and thermal ratings to adapt it for relay and control device operation. It is designed for use on circuits not exceeding 5,000 volts, line-to-line, and is available in all standard single, primary-current ratings 15 to 800 amperes inclusive.

The unit is butyl-molded, a construction in which the butyl serves as insulator, support and casing. Butyl provides a homogeneous insulation that resists oxidation, arc-tracking and moisture. It will not crack from coil expansion nor from changes over a wide range of ambient temperature. The insulation will meet the test requirements of the 5-kv standard insulation class, which call for a one-minute 19-kv test at 60 cycles and a full-wave impulse test at 60 kv.

It is designed for continuous operation at 100 per cent of rated current in 55 C ambient temperature without exceeding the allowable 30 C rise.

HYDRAULIC FLUID

▲ Two new fire-resistant hydraulic fluids engineered to meet special high and low viscosity requirements now are available in commercial quantities from Monsanto Chemical Co.

The new fluids, trademarked Pydraul 150 and Pydraul 600, are reported to have the same fire-resistance, lubricity, non-toxicity and non-corrosiveness as the company's Pydraul F-9. They supplement the latter product by providing viscosities which more fully encompass the range of hydraulic fluid requirements, according to Monsanto.

Pydraul 150, with a viscosity index of 170 and a pour point of –55 F, is designed for use in outdoor installations where systems are exposed to ambient temperatures.

At the opposite end of the viscosity range, the new Pydraul 600 has a viscosity index of 30 and a pour point of 15 F. Designed for presses, compressors and die-casting equipment, its S.U.S. viscosity of 625 at 100 F compares with 220 for Pydraul F-9 and 150 for the new Pydraul 150.

AIR COMPRESSOR

▲ A 125 hp electric-driven air compressor has been added to the Ingersoll-Rand line of air-cooled two-stage Type 40 stationary compressors.

Some of the new features of this unit are: single-core, horizontal-flow intercooler, new shrouding, force-feed lubrication, full free-air unloading and a new version of the Ingersoll-Rand "Channel Valve." These and other features make the 125-M compressor a neat, accessible, compact and efficient package that is easily adapted to either permanent or temporary jobs. It can be installed with a minimum of foundation, time and labor.

Either constant-speed control or dual control can be furnished. Dual control is available with either automatic or manual selection, permitting operation at constant-speed or automatic start-and-stop, whichever is deemed more economical.

This unit adds a 125 hp unit to the Type 40 line which already includes sizes of 25, 40, 50, 75 and 100 hp.

SPEED REDUCER

▲ Foote Bros. Gear and Machine Corp. announces its new "Line-O-Power" speed reducers with capacities ranging from fractional hp to 150 hp. The two most important basic features of the new models are simplicity and compactness of design and exceptional durability of all components. The manufacturers say that by accomplishing these two design goals, they have produced a line of speed reducers that are easy to maintain, offer dependable performance, and have an unusually long "life expectancy," even with constant usage.

The new speed reducers employ lifetime gears, to provide higher capacities in a compact unit. In addition, the input and output shafts are in a direct line, to permit coupling of motor and speed reducer in less space. Another feature is the exclusive Foote Bros. "Spline Drive" pinion,

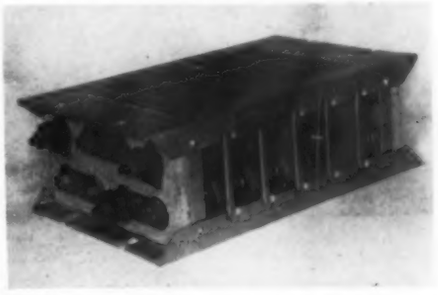
GUYAN RESISTORS

Engineered and designed to eliminate resistor maintenance on troublesome mill applications.

Non-breakable helical coil construction ends burnouts due to warping and buckling of grids.

Sturdy, rugged steel construction eliminates shock and vibration troubles.

Custom designed for your conditions including excessive graphite accumulations.



With a quarter century of resistor engineering, we invite you to take advantage of our experience.

For complete information on Guyan Resistors, please contact the nearby Guyan Representative or our main plant at Logan, W. Va.

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Birmingham, Ala.—Ebbert & Kirkman Co., 2313 6th Ave. So.

Buffalo, N.Y.—Buffalo Electric Co. West Mohawk St.

Chicago, Ill.—John K. Byrne, 1515 W. Howard St.

Cleveland, Ohio—H. V. Varney Co., 625 Engineers Bldg.

Detroit, Mich.—Plant Equipment Co., General Motors Bldg.

Philadelphia, Pa.—George I. Wright 811 Commercial Trust Bldg.

Pittsburgh 27, Pa.—P. R. Holden, 4860 Elmwood Dr.

●

GUYAN MACHINERY COMPANY

LOGAN, W. VA.

making it easy for the user to change reduction ratios. The range of nominal ratios for double, triple and quadruple reductions is from 5.06 to 1478.

CARTRIDGE BEARING

▲ A new cartridge roller bearing, housed in a flexible neoprene housing, has been introduced by Rollway Bearing Co. Called the "Flexi-Flange," the new bearing is easily installed and lubricated, operates almost dust-free, has excellent load-carrying characteristics, and allows for alignment of shafts.

Completely assembled and self-contained, the new bearing is installed with only the aid of a hand drill and wrench. Of steel cage construction, the bearing consists of a roller assembly, outer race, and optional inner race. Roller trunions extending through holes in the end plates hold the rollers in position. A series of stay rods separate the end plates, correctly spacing them.

The hardened bearing race is inserted into the steel stamping providing clearance of approximately .005-in. between the bore of the stamping and the outside diameter of the race. Since both race and stamping are bonded permanently together by neoprene, this clearance allows a misalignment of at least one degree between the shaft and the housing.

A typical load passage through the bearing is as follows: load is transmitted from the shaft to the rollers, from the rollers to the outer race, and finally to the stamping. The neoprene housing flexes, adjusting to changes in alignment of the shaft.

The bearing end plates, located by machined shoulders in the bore of the bearing race, center the roller assembly to the housing flange. An area between the retainer and the housing seals retains lubricant for long operating periods. An alemite fitting, attached to the housing, is used to replenish the bearing's supply of grease.

Shaft limits for the new bearing are $\frac{1}{2}$ to $1\frac{7}{16}$ in. The $\frac{1}{2}$-in. size supports a radial load of 415 lb at 100 rpm; at the same rpm, the $1\frac{7}{16}$-in. size has a maximum capacity of 1665 lb.

Ordinarily, the cartridge bearing is equipped with hardened and unground rollers to run directly upon heat-treated shafts. But for equipment applications where it is impractical to heat treat a shaft, Rollway offers a hardened and unground sleeve held in place by a locking collar. For fairly light loads, the bearing can be supplied with unhardened and unground rollers, eliminating the need for heat treated shafts. To take higher speeds, hardened and ground rollers are available.

Book Reviews . . .

"Birth and Development of the Geological Sciences," by Frank Dawson Adams, was recently published by Dover Publications, Inc., 1780 Broadway, New York 19, N. Y., 506 pp, 5¼ × 8 in., paper bound, price $1.95. This is an authoritative history of the earth sciences and includes opinions of 500 writers from Aristotle to Humboldt. This book is an unabridged republication of the first edition which was first issued in 1938. It provides a historical background of the origin of metals, ores, mountains and geological features which provide a basis for a better understanding of geology.

FLEXIDYNE

THE DRY FLUID DRIVE

NEW! REVOLUTIONARY!

Handles difficult starting problems and gives a *new* kind of protection against shock and overloads. The dry flow-charge can be varied to give exact torque you need. When load reaches normal speed there is zero slip, giving 100% efficiency. Write for bulletin with detailed information on Flexidyne Drives and Flexidyne Couplings.

DODGE MANUFACTURING CORPORATION, 5900 Union St., Mishawaka, Ind.

DODGE

of Mishawaka, Ind.

FAST···LEGIBLE BILLET MARKING!

now made possible with the NEW

MODEL 701 PNEUMATIC BILLET MARKER

This new, compact unit stamps ends of billets 4" x 4" or larger with a deep, legible mark as shown above. Unit is mounted on an I-beam track and powered by heavy duty air cylinder. Quick change type holder is kept in stamping position at all times without special guides.

WRITE for complete data.

Mecco SAFETY MARKING TOOLS

M.E.CUNNINGHAM CO.

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SINGLE STAGE TURBINE

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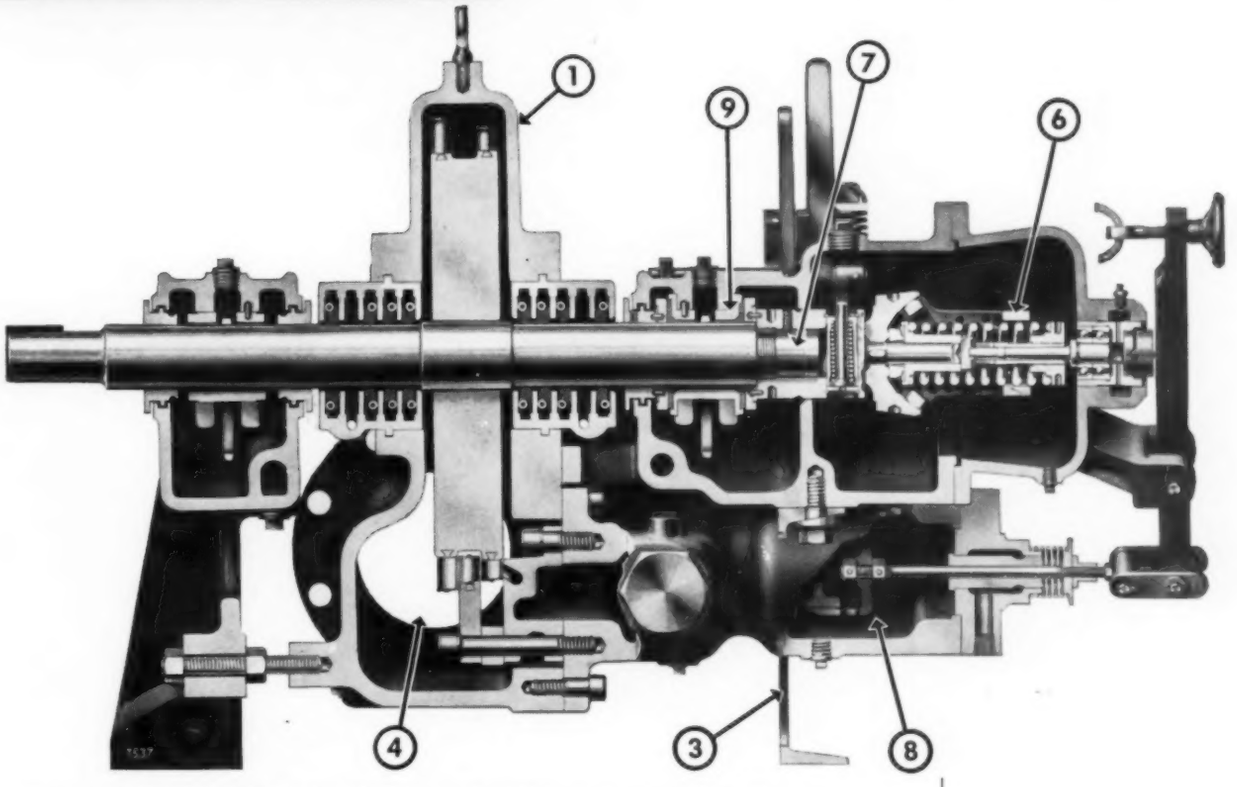

1 Case and Cover Split Horizontally on centerline for ease of maintenance.

2 True Centerline Casing Support assures distortion-free radial expansion. *Not shown.*

3 Flexible Support at governor end provides for axial expansion.

4 Exhaust Opening either right or left side for installation flexibility.

5 Steam Strainer, protecting trip and governor valves, is *removable* for cleaning without breaking steam connections. *Not shown.*

6 Constant Speed Governor features governor weights pivoted around frictionless surfaces.

7 Complete Governor Assembly is now *replaceable as a unit.*

8 Balanced Single Seated Main Governor Valve has proportional flow characteristics for sensitive, positive control.

9 Shaft Locating Bearing of adjustable double collar type.

Horsepower: 100 MAX
Steam Pressure: 300 PSIG MAX
Steam Temperature: 550F MAX
Exhaust Pressure: 25 PSIG MAX
Speed: 4,000 RPM MAX
Steam Inlet: 2"–250# ASA FLG.
Exhaust: 6"–150# ASA FLG.
Weight: 1,200 LB

Here's the new De Laval HCB Single Stage Turbine which is now "on the shelf" . . . ready for immediate shipment. This mechanical drive turbine is simple, rugged, designed for long economical life and low maintenance. For example, note the true centerline casing support, the replaceable governor, the removable steam strainer. Investigate all the advantages of this versatile driver. It is ready to handle—*at low cost*—a variety of applications in your plant.

Send for new Bulletin 4206
which gives vital facts and figures

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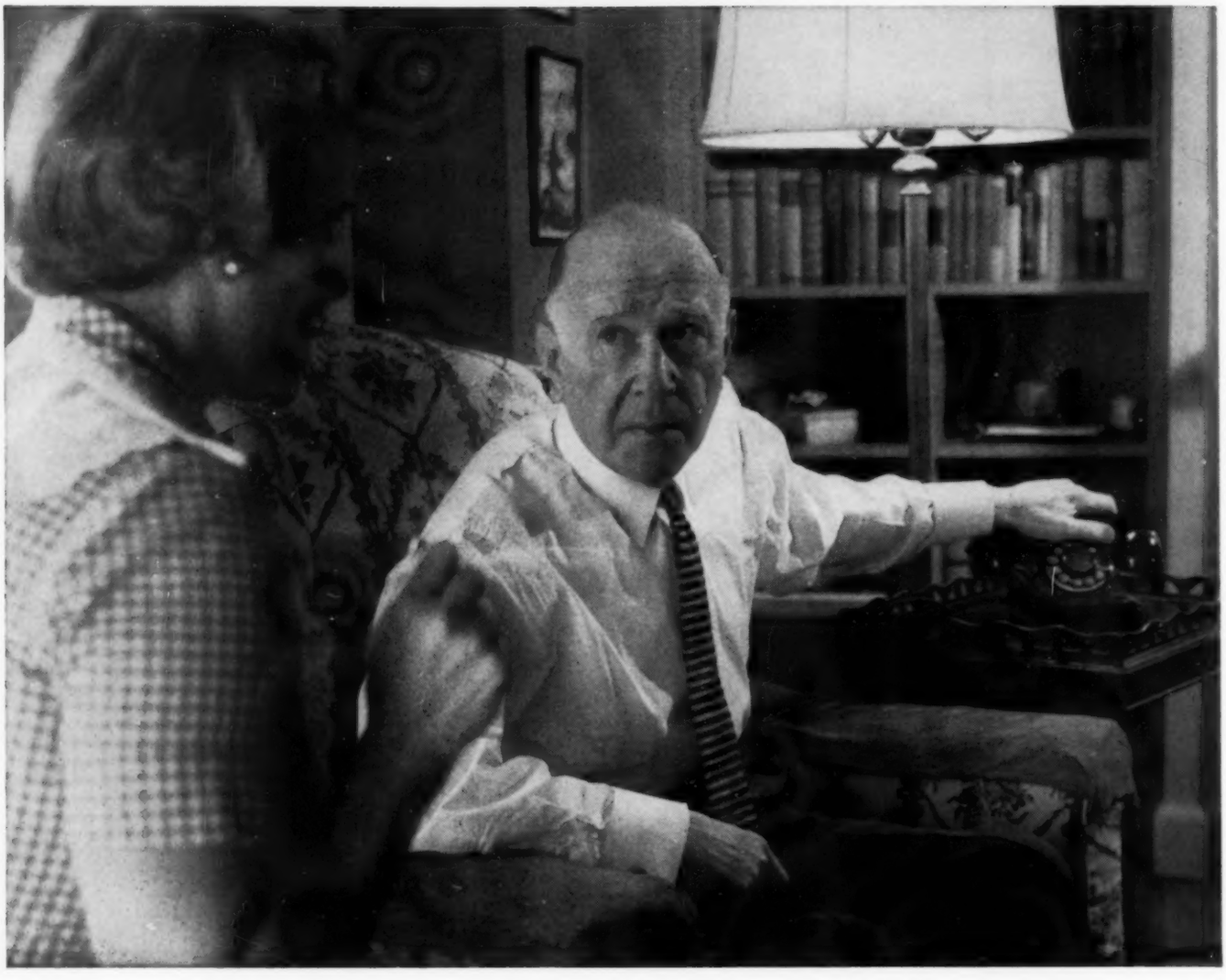

The Word We Dreaded

My husband and I were together when the phone rang. He got up to answer it and I held my breath as I heard his quiet, "Yes, Doctor?"

Then he put the receiver down carefully. His face, when he turned to me, was gaunt and lined, but he was trying to smile.

"Was it—the laboratory tests?" I asked.

He nodded. "We'd better get my bag packed," he said gently. "They want me in the hospital this evening."

We had realized for months that something was wrong. But the pressure of his business postponed action. "Guess I'm a little off my feed," was all he would say.

It took our family physician only ten minutes to change that attitude. He made an immediate appointment with a specialist. And at the end of an anguished week we knew. The laboratory tests confirmed the word we dreaded—"Cancer."

That was a year ago. Modern cancer research saved my husband. That... and the surgeon's skill, the strength of our faith and his own fighting heart. He is alive and well today. For us the story has had a happy ending.

Yet it *isn't* ended. When we think of the thousands of other families tragically broken every year, we feel we still have work to do. Many types of cancer *can be cured* if caught in time. We tell our friends, "If there are symptoms you don't understand, see your doctor at once." And we *give* to support the constant research of the American Cancer Society in finding the causes and reducing the incidence of cancer.

Strike back at CANCER . . . man's cruelest enemy . . . GIVE

American Cancer Society

GENTLEMEN:

I want to help conquer Cancer.

☐ Please send me free information about Cancer.

☐ Enclosed is my contribution of $____ to the Cancer Crusade.

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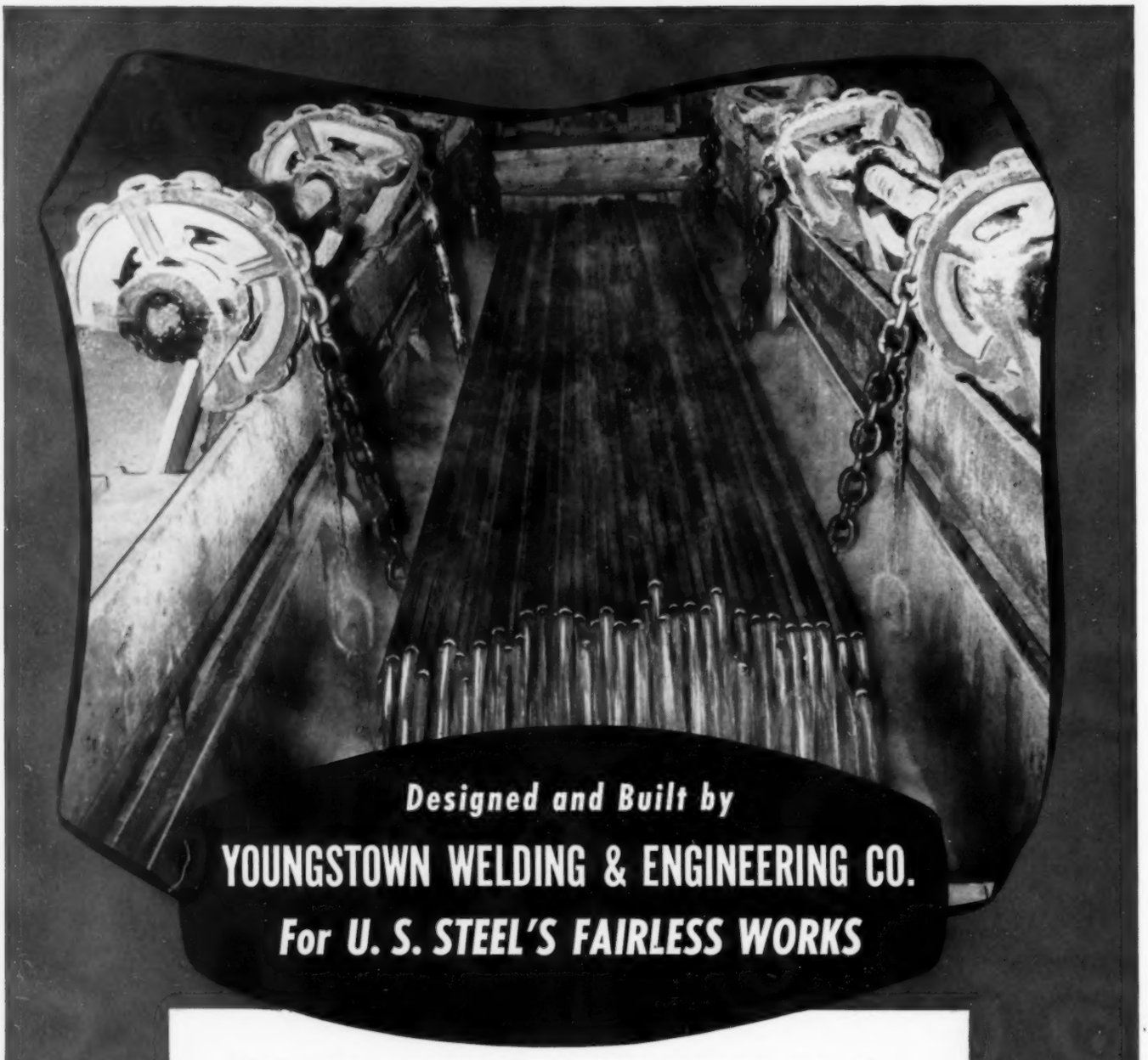

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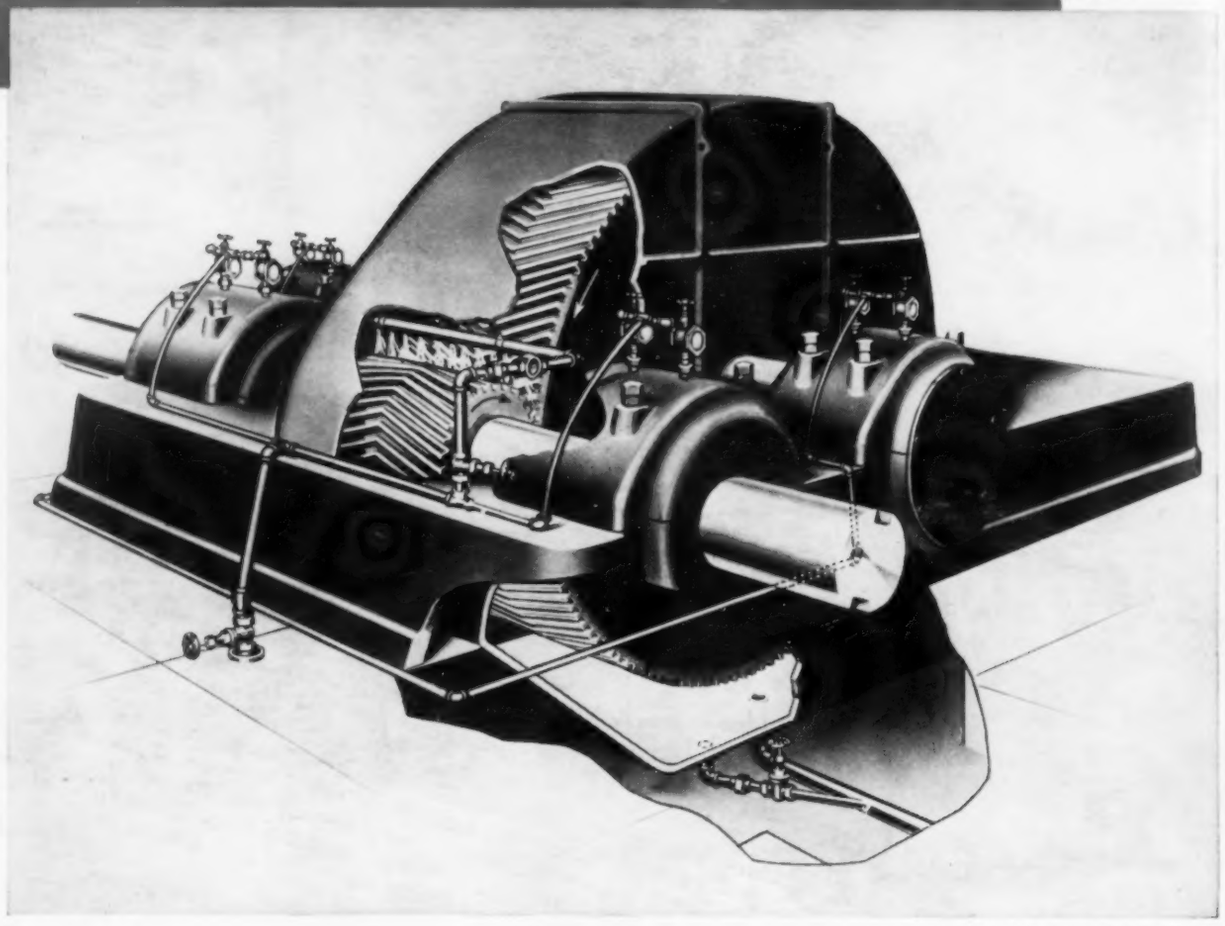

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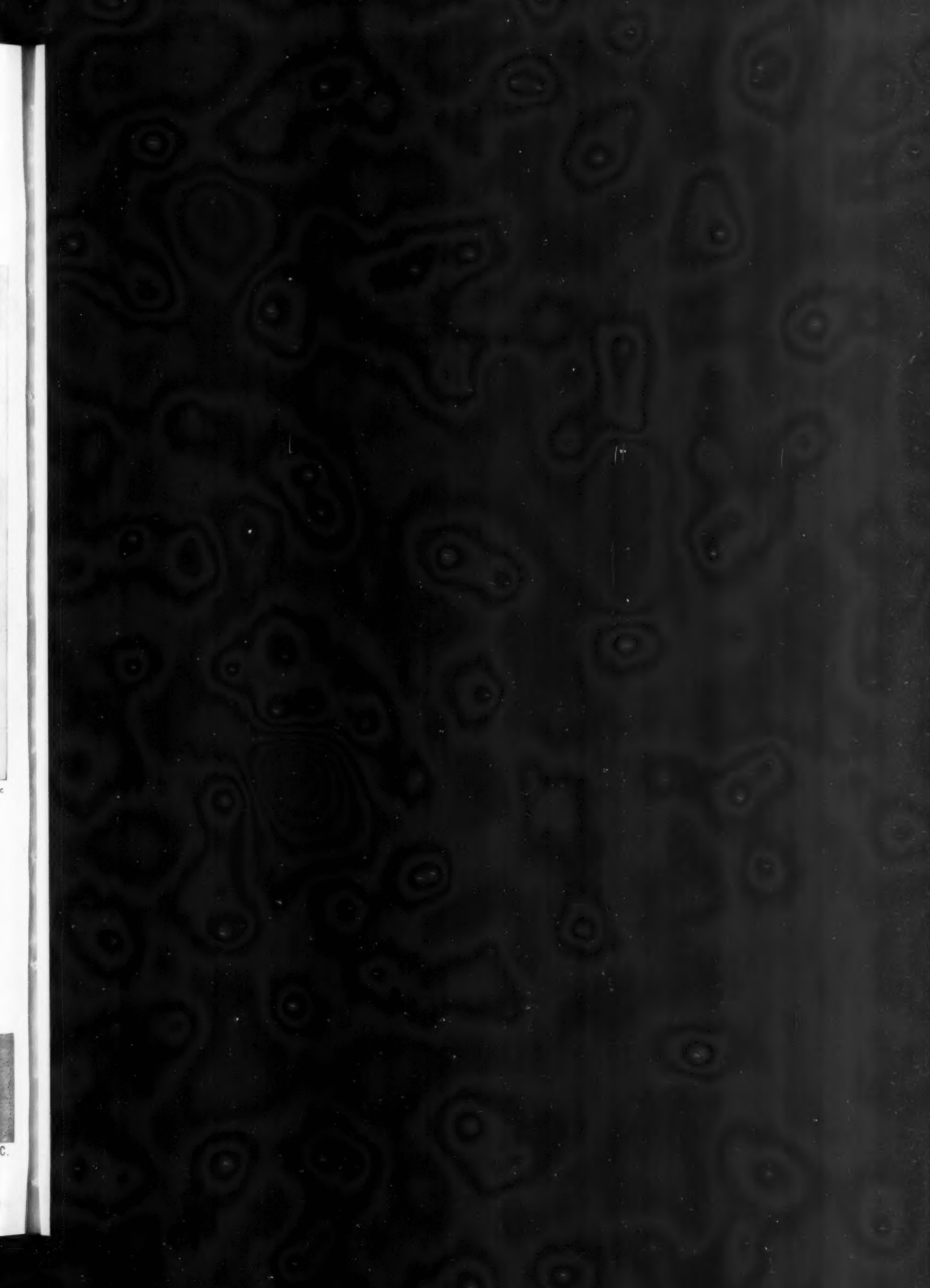
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